ITEM 24 BUILDING, FIRE AND OTHER
SFM 03/04
Part 12, Sub-items 24-1 and 24-2
Chapters 12-1, 12-4-1, 12-7-1, 12-7-2, 12-7-3, 12-7-4, 12-8-1, Appendix 12-8-1A, Appendix 12-8-1B, 12-10-1, 12-10-2, 12-10-3, 12-71, 12-72-1, 12-72-2 and 12-72-3

EXPRESS TERMS

ITEM 24-1

Chapter 12-1 ADMINISTRATION

SECTION 12-1-101 - TITLE, PURPOSE AND SCOPE

12-1-101.1 Title. *These regulations shall be known as the Uniform Building Code, may be cited as such and will be referred to herein as ``this code." For the State of California, these regulations shall be known as the California Building Code. The provisions contained in the California Building Code of the (compiled) California Building Standards Code as defined in Section 18910, Health and Safety Code, may be cited as such and are referred to hereafter as "these regulations" or "these building standards" or "this code."*

12-1-101.2 Purpose. *The purpose of this code is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location and maintenance of all buildings and structures within this jurisdiction and certain equipment specifically regulated herein.*
The purpose of this code is not to create or otherwise establish or designate any particular class or group of persons who will or should be especially protected or benefited by the terms of this code.

121101.3 Scope. *The provisions of this code shall apply to the construction, alteration, moving, demolition, repair, maintenance and use of any building or structure within this jurisdiction, except work located primarily in a public way, public utility towers and poles, mechanical equipment not specifically regulated in this code, and hydraulic flood control structures. For additions, alterations, moving and maintenance of buildings and structures, see Chapter 34. For temporary buildings and structures see Section 3103 and Appendix Chapter 31. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Wherever in this code reference is made to the appendix, the provisions in the appendix shall not apply unless specifically adopted.*

12-1-101.3.1 *The provisions of the model codes which are adopted by these regulations are applicable to all occupancy groups and uses regulated by this code. The amendments to the model codes are applicable only to those occupancies or uses which the state agency adopting the amendments is authorized to regulate as listed in Section 12-1101.11.*

NOTE: *It is not the intent of this section that every existing occupancy within the scope of the state fire marshal's jurisdiction mandatorily conform or be made to conform to the new construction requirements relative to fire, panic and explosion safety. Reasonable judgment must be exercised by the enforcing agency in the application of these building standards to existing occupancies.*

12-1-101.4 Effective Date.

12-1-101.4.1 *One hundred and eighty days after the date of publication, or as otherwise noted herein.*

NOTE: *For clarification purposes, the applicable subsection of the Health and Safety Code section is repeated.*

Sec. 18941.5. Application and Effective Date. *The building standards contained in the Uniform Fire Code, published by the International Conference of Building Officials and the Western Fire Chiefs Association, the Uniform Building Code published by the International Conference of Building Officials, the Uniform Plumbing Code published by the International Association of Plumbing and Mechanical Officials, the National Electrical Code? published by the National Fire Protection Association, the Uniform Mechanical Code published by the International Conference of Building Officials and the International Association of Plumbing and Mechanical Officials, as referenced in the State Building Standards Code, shall apply to all occupancies throughout the state and shall become effective 180 days after publication in the State Buildings Standards Code by the State Building Stand- ards Commission, or at a later date after publication established by the commission.*

12-1-101.5 Format. *This part fundamentally adopts the UBC by reference on a chapter-by-chapter basis. Such adoption is reflected in the adoption table of each chapter of this part. When the adoption table of a chapter of this part makes no reference to a specific chapter of the UBC, such chapter of the UBC is not adopted as a portion of this code.*

12-1-101.6 Validity. *If any chapter section, subsection, sentence, clause or phrase of this code is for any reason held to be unconstitutional, contrary to statute, exceeding the authority of the state as stipulated by statutes, or otherwise inoperative, such decision shall not affect the validity of the remaining portion of this code.*

12-1-101.7 Standard Reference Documents. *The codes, standards and publications adopted and set forth in this code, including other codes, standards and publications referred to therein are, by title and date of publication, hereby adopted as standard reference documents of this code. When this code does not specifically cover any subject relating to building design and construction, recognized fire-prevention engineering practices shall be employed. The National Fire Codes and the Fire Protection Handbook of the National Fire Protection Association may be used as authoritative guides in determining recognized fire-prevention engineering practices.*

12-1-101.8 Nonbuilding Regulations. *Requirements contained in the UBC, or in any other referenced standard, code or document, which are not building standards as defined in Section 18912, Health and Safety Code, shall not be construed as part of the provisions of this code. For the applicability of regulations relating to maintenance, operation, use, limitations or prohibitions, and similar nonbuilding regulations, see other titles of the California Code of Regulations.*

121101.9 Order of Precedence.

12-1-101.9.1 General. *In the event of any differences between these building standards and the standard reference documents , he text of these building standards shall govern. Where a specific provision varies from a general provision, the specific provision shall apply.*

12-1-101.9.2 Fire Codes. *Nothing in these building standards shall diminish the requirements of the state fire marshal.*

12-1-101.10 Availability of Code. *For clarification purposes, the applicable subsection of the Health and Safety Code section is repeated.*

Sec. 18942 (d). *Each city, county, and city and county, including charter cities, shall obtain and maintain with all revisions on a current basis, at least one copy of the building standards and other state regulations relating to buildings published in Title 8, 19, 20, 24 and 25 of the California Code of Regulations. These codes shall be maintained in the office of the building official responsible for the administration and enforcement of the provisions of this part.*

12-1-101.11 Application.

Vesting Authority. *When adopted by a state agency, the provisions of these regulations shall be enforced by the appropriate enforcing agency, but only to the extent of authority granted to such agency by the state legislature. Following is a list of the state agencies that adopt building standards, the specific scope of application of the agency responsible for enforcement, and the specific statutory authority of each agency to adopt and enforce such provisions of building standards of this code, unless otherwise stated.*

12-1-101.11.14 SFM-Office of the State Fire Marshal.
Any building or structure used or intended for use as an asylum, jail, mental hospital, hospital, sanitarium, home for the aged, children's nursery, children's home, school or any similar occupancy of any capacity.
Any theater, dancehall, skating rink, auditorium, assembly hall, meeting hall, nightclub, fair building, or similar place of assemblage where 50 or more persons may gather together in a building, room or structure for the purpose of amusement, entertainment, instruction, deliberation, worship, drinking or dining, awaiting transportation, or education. Any building or structure which is open to the public and is used or intended to be used for the showing of motion pictures when an admission fee is charged and when the building or structure has a capacity of 10 or more persons.

Authority Cited-Health and Safety Code Section 13143.
Reference-Health and Safety Code Section 13143.
Small Family Day-care Homes *Authority Cited-Health and Safety Code Sections 1597.45, 1597.54, 13143 and 17921.*
Reference-Health and Safety Code Section 13143

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Large Family Day-care Homes *Authority Cited-Health and Safety Code Sections 1597.46, 1597.54 and 17921.*
Reference-Health and Safety Code Section 13143.

Residential Facilities and Residential Facilities for the Elderly
Authority Cited-Health and Safety Code Section 13133.
Reference-Health and Safety Code Section 13143.

Any state institution or other state-owned or state-occupied building.
Authority Cited-Health and Safety Code Section 13108.
Reference-Health and Safety Code Section 13143.

High-rise Structures *Authority Cited-Health and Safety Code Section 13211.*
Reference-Health and Safety Code Section 13143.

Motion Picture Production Studios *Authority Cited-Health and Safety Code Section 13143.1.*
Reference-Health and Safety Code Section 13143.

Organized Camps *Authority Cited-Health and Safety Code Section 18897.3.*
Reference-Health and Safety Code Section 13143.
All hotels, motels, lodging houses, apartment houses and dwellings, including congregate residences and buildings and structures accessory thereto.

Multiple-story structures existing on January 1, 1975, let for human habitation, including and limited to, hotels, motels, apartment houses, less than 75 feet (22 860 mm) above the lowest floor level having building access, wherein rooms used for sleeping are let above the ground floor.
Authority Cited-Health and Safety Code Sections 13143.2 and 17921.

Certified family-care homes, out-of-home placement facilities, halfway houses, drug and/or alcohol rehabilitation facilities and any building or structure used or intended for use as a home or institution for the housing of any person of any age when such person is referred to or placed within such home or institution for protective social care and supervision services by any governmental agency.
Authority Cited-Health and Safety Code Section 13143.6.

Tents, awnings or other fabric enclosures used in connection with any occupancy.
Authority Cited-Health and Safety Code Section 13116.
Enforcing Agency-Pursuant to Section 13146, Health and Safety Code: The responsibility for enforcement of building standards adopted by the state fire marshal and published in the California Building Standards Code relating to fire and panic safety and other regulations of the Office of the State Fire Marshal shall be as follow.

1. The city, county, or city and county with jurisdiction in the area affected by the standard or regulation shall delegate the enforcement of the building standards relating to fire and panic safety and other regulations of the state fire marshal as they relate to Group R, Division 3 dwellings, as described in Section 310.1 of Part 2 of the California Building Standards Code, to either of the following:

1.1 The chief of the fire authority of the city, county, or city and county, or an authorized representative.

1.2 The chief building official of the city, county, or city and county, or an authorized representative.

2. The chief of any city or county fire department or of any fire- protection district, and authorized representatives, shall enforce within the jurisdiction the building standards and other regulations of the state fire marshal, except those described in Item 1 or 4.

3. The state fire marshal shall have authority to enforce the building standards and other regulations of the state fire marshal in areas outside of corporate cities and districts providing fire-protection services.

4. The state fire marshal shall have authority to enforce the building standards and other regulations of the state fire marshal in corporate cities and districts providing fire-protection services on request of the chief fire official or the governing body.

5. Any fee charged pursuant to the enforcement authority of this section shall not exceed the estimated reasonable cost of providing the service for which the fee is charged pursuant to Section 66014 of the Government Code.

***SECTION 12-1-102 - UNSAFE BUILDINGS OR STRUCTURES** All buildings or structures regulated by this code which are structurally unsafe or not provided with adequate egress, or which constitute a fire hazard, or are otherwise dangerous to human life are, for the purpose of this section, unsafe. Any use of buildings or structures constituting a hazard to safety, health or public welfare by reason of inadequate maintenance, dilapidation, obsolescence, fire hazard, disaster, damage or abandonment is, for the purpose of this section, an unsafe use. Parapet walls, cornices, spires, towers, tanks, statuary and other appendages or structural members which are supported by, attached to, or a part of a building and which are in deteriorated condition or otherwise unable to sustain the design loads which are specified in this code are hereby designated as unsafe building appendages.*

All such unsafe buildings, structures or appendages are hereby declared to be public nuisances and shall be abated by repair, rehabilitation, demolition or removal in accordance with the procedures set forth in the Dangerous Buildings Code or such alternateprocedures as may have been or as may be adopted by this jurisdiction. As an alternative, the building official, or other employee or official of this jurisdiction as designated by the governing body, may institute any other appropriate action to prevent, restrain, correct or abate the violation.

***12-1-102.1 [For SFM] Fire Hazard.** No person, including but not limited to the state and its political subdivisions, operating any occupancy subject to these regulations shall permit any fire hazard, as defined in this section, to exist on premises under their control, or fail to take immediate action to abate a fire hazard when requested to do so by the enforcing agency.*

***NOTE:** "Fire hazard" as used in these regulations means any condition, arrangement or act which will increase, or may cause an increase of, the hazard or menace of fire to a greater degree than customarily recognized as normal by persons in the public service of preventing, suppressing or extinguishing fire; or which may obstruct, delay or hinder, or may become the cause of obstruction, delay or hindrance to the prevention, suppression or extinguishment of fire.*

***SECTION 12-1-103 - VIOLATIONS** It shall be unlawful for any person, firm or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert or demolish, equip, use, occupy or maintain any building or structure or cause or permit the same to be done in violation of this code.*

***12-1-103.1 [For SFM]** Pursuant to Health and Safety Code Section 13112, any person who violates any order, rule or regulation of the state fire marshal is guilty of a misdemeanor punishable by a fine of not less than $100.00 or more than $500.00, or by imprisonment for not less than six months, or by both. A person is guilty of a separate offense each day during which he or she commits, continues or permits a violation of any provision of, or any order, rule or regulation of, the state fire marshal as contained in this code.*

Any inspection authority who, in the exercise of his or her authority as a deputy state fire marshal, causes any legal complaints to be filed or any arrest to be made shall notify the state fire marshal immediately following such action.

SECTION 12-1-104 - ORGANIZATION AND ENFORCEMENT 12-1-104.1
Creation of Enforcement Agency. *There is hereby established in this jurisdiction a code enforcement agency which shall be under the administrative and operational control of the building official.*

12-1-104.2 Powers and Duties of Building Official.

12-1-104.2.1 General. *The building official is hereby authorized and directed to enforce all the provisions of this code. For such purposes, the building official shall have the powers of a law enforcement officer.*

[For SFM] Pursuant to Health and Safety Code Section 13146, the responsibility for enforcement of building standards adopted by the state fire marshal and published in the California Building Standards Code relating to fire and panic safety and other regulations of the state fire marshal shall be as follows:

1. The city, county, or city and county with jurisdiction in the area affected by the standard or regulation shall delegate the enforcement of the building standards relating to fire and panic safety and other regulations of the state fire marshal as they relate to Group R, Division 3 dwellings, as described in Section 1201 of Part 2 of the California Building Standards Code, to either of the following:

1.1 The chief of the fire authority of the city, county, or city and county, or an authorized representative.

1.2 The chief building official of the city, county, or city and county, or an authorized representative.

2. The chief of any city or county fire department or of any fire- protection district, and his or her authorized representatives, shall enforce within its jurisdiction the building standards and other regulations of the state fire marshal, except those described in Item 1 or 4.

3. The state fire marshal shall have authority to enforce the building standards and other regulations of the state fire marshal in areas outside of corporate cities and districts providing fire- protection services.

4. The state fire marshal shall have authority to enforce the building standards and other regulations of the state fire marshal in corporate cities and districts providing fire-protection services upon request of the chief fire official or the governing body.

5. Any fee charged pursuant to the enforcement authority of this section shall not exceed the estimated reasonable cost of providing the service for which the fee is charged, pursuant to Section 66014 of the Government Code.

Pursuant to Health and Safety Code Section 13108, upon the written request of the chief fire official of any city, county or fire- protection district, the state fire marshal may authorize such chief fire official and his or her authorized representatives, in their geographical area of responsibility, to make fire-prevention inspections of state-owned or state-occupied buildings, other than state institutions, for the purpose of enforcing the regulations relating to fire and panic safety adopted by the state fire marshal pursuant to this section and building standards relating to fire and panic safety published in the State Building Standards Code. Authorization from the state fire marshal shall be limited to those fire departments or fire districts which maintain a fire-prevention bureau staffed by paid personnel.

Pursuant to Health and Safety Code Section 13108, any requirement or order made by any chief fire official who is authorized by the state fire marshal to make fire-prevention inspections of state-owned or state-occupied buildings, other than state institutions, may be appealed to the state fire marshal. The state fire marshal shall, upon receiving an appeal and subject to the provisions of Chapter 5 (commencing with Section 18945) of Part 2, 5 of Division 13 of the Health and Safety Code, determine if the requirement or order made is reasonably consistent with the fire and panic safety regulations adopted by the Office of the State Fire Marshal and building standards relating to fire and panic safety published in the California Building Code.

The building official shall have the power to render interpretations of this code and to adopt and enforce rules and supplemental regulations in order to clarify the application of its provisions.

Such interpretations, rules and regulations shall be in conformance with the intent and purpose of this code.

[For SFM] Any person may request a code interpretation from the state fire marshal relative to the intent of any regulation or provision adopted by the state fire marshal. When the request relates to a specific project, occupancy or building, the state fire marshal shall review the issue with the appropriate local enforcing agency prior to rendering such code interpretation.

12-1-104.2.2 Deputies. *In accordance with prescribed procedures and with the approval of the appointing authority, the building official may appoint such number of technical officers and inspectors and other employees as shall be authorized from time to time. The building official may deputize such inspectors or employees as may be necessary to carry out the functions of the code enforcement agency.*

12-1-104.2.3 Right of entry. *When it is necessary to make an inspection to enforce the provisions of this code, or when the building official has reasonable cause to believe that there exists in a building or upon a premises a condition which is contrary to or in violation of this code which makes the building or premises unsafe, dangerous or hazardous, the building official may enter the building or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that if such building or premises be occupied that credentials be presented to the occupant and entry requested. If such building or premises be unoccupied, the building official shall first*

make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. If entry is refused, the building official shall have recourse to the remedies provided by law to secure entry.

[For SFM] The fire chief of any city, county or fire-protection district, or such person's authorized representative, may enter any state institution or any other state-owned or state-occupied building for the purpose of preparing a fire-suppression preplanning program or for the purpose of investigating any fire in a state- occupied building.

[For SFM] The state fire marshal, his or her deputies or salaried assistants, the chief of any city or county fire department or fire protection district and his or her authorized representatives may enter any building or premises not used for dwelling purposes at any reasonable hour for the purpose of enforcing this chapter.
The owner, lessee, manager or operator of any such building or premises shall permit the state fire marshal, his or her deputies or salaried assistants and the chief of any city or county fire department or fire-protection district and his or her authorized representatives to enter and inspect them at the time and for the purpose stated in this section.

12-1-104.2.4 Stop orders. *Whenever any work is being done contrary to the provisions of this code, or other pertinent laws or ordinances implemented through the enforcement of this code, the building official may order the work stopped by notice in writing served on any persons engaged in the doing or causing such work to be done, and any such persons shall forthwith stop such work until authorized by the building official to proceed with the work.*

12-1-104.2.5 Occupancy violations. *Whenever any building or structure or equipment therein regulated by this code is being used contrary to the provisions of this code, the building official may order such use discontinued and the structure, or portion thereof, vacated by notice served on any person causing such use to be continued. Such person shall discontinue the use within the time prescribed by the building official after receipt of such notice to make the structure, or portion thereof, comply with the requirements of this code.*

12-1-104.2.6 Liability. *The building official charged with the enforcement of this code, acting in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance shall not thereby be rendered personally liable for damages that may accrue to persons or property as a result of an act or by reason of an act or omission in the discharge of such duties. A suit brought against the building official or employee because of such act or omission performed by the building official or employee in the enforcement of any provision of such codes or other pertinent laws or ordinances implemented through the enforcement of this code or enforced by the code enforcement agency shall be defended by this jurisdiction until final termination of such proceedings, and any judgment resulting therefrom shall be assumed by this jurisdiction. This code shall not be construed to relieve from or lessen the responsibility of any person owning, operating or controlling any building or structure for any damages to persons or property caused by defects, nor shall the code enforcement agency or its parent jurisdiction be held as assuming any such liability by reason of the inspections authorized by this code or any permits or certificates issued under this code.*

12-1-104.2.7 Modifications. *When there are practical difficulties involved in carrying out the provisions of this code, the building official may grant modifications for individual cases. The building official shall first find that a special individual reason makes the strict letter of this code impractical and that the modification is in conformance with the intent and purpose of this code and that such modification does not lessen any fire-protection requirements or any degree of structural integrity. The details of any action granting modifications shall be recorded and entered in the files of the code enforcement agency.*

12-1-104.2.8 Alternate materials, alternate design and methods of construction. *The provisions of this code are not intended to prevent the use of any material, alternate design or method of construction not specifically prescribed by this code, provided any alternate has been approved and its use authorized by the building official. The building official may approve any such alternate, provided the building official finds that the proposed design is satisfactory and complies with the provisions of this code and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation. The building official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the files of the code enforcement agency.*
12-1-104.2.9 Tests. *Whenever there is insufficient evidence of compliance with any of the provisions of this code or evidence that any material or construction does not conform to the requirements of this code, the building official may require tests as proof of compliance to be made at no expense to this jurisdiction.*
Test methods shall be as specified by this code or by other recognized test standards. If there are no recognized and accepted test methods for the proposed alternate, the building official shall determine test procedures. All tests shall be made by an approved agency. Reports of such tests shall be retained by the building official for the period required for the retention of public records.

12-1-104.2.10 Cooperation of other officials and officers.
The building official may request, and shall receive, the assistance and cooperation of other officials of this jurisdiction so far as is required in the discharge of the duties required by this code or other pertinent law or ordinance.

SECTION 12-1-105 - BOARD OF APPEALS

12-1-105.1 General. *In order to hear and decide appeals of orders, decisions or determinations made by the building official relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals consisting of members who are qualified by experience and training to pass on matters pertaining to building construction and who are not employees of the jurisdiction. The building official shall be an ex oficio member of and shall act as secretary to said board but shall have no vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the building official.*

12-1-105.1.1 [For SFM] Right to Appeal. *For clarification purposes, the applicable subsection of the Health and Safety Code section is repeated.*

Sec. 18945. *Any person adversely affected by any regulation, rules, omission, interpretation, decision or practice of any state agency, respecting the administration of any building standard may appeal the issue for resolution to the Building Standards Commission.*

If any local agency having authority to enforce a state building standard and any person adversely affected by any regulation, rule, omission, interpretation, decision or practice of such agency respecting such building standard both wish to appeal the issue for resolution to the commission, then both parties may appeal to the commission. The commission may accept such appeal only if the commission determines that the issues involved in such appeal have statewide significance.

12-1-105.2 Limitations of Authority. *The board of appeals shall have no authority relative to interpretation of the administrative provisions of this code nor shall the board be empowered to waive requirements of this code.*

SECTION 12-1-106 - PERMITS

12-1-106.1 Permits Required. *Except as specified in Section 12-1-106.2 of this section, no building or structure regulated by this code shall be erected, constructed, enlarged, altered, repaired, moved, improved, removed, converted or demolished unless a separate permit for each building or structure has first been obtained from the building official.*

12-1-106.2 Work Exempt from Permit. *A building permit shall not be required for the following:*

1. One-story detached accessory buildings used as tool and storage sheds, playhouses and similar uses, provided the projected roof area does not exceed 120 square feet (11.15 m2).

2. Fences not over 6 feet (1829 mm) high.

3. Oil derricks.

4. Movable cases, counters and partitions not over 5 feet 9 inches (1753 mm) high.

5. Retaining walls which are not over 4 feet (1219 mm) in height measured from the bottom of the footing to the top of the wall, unless supporting a surcharge or impounding Class I, II or III-A liquids.

6. Water tanks supported directly upon grade if the capacity does not exceed 5,000 gallons (18 927 L) and the ratio of height to diameter or width does not exceed 2 to 1.

7. Platforms, walks and driveways not more than 30 inches (762 mm) above grade and not over any basement or story below.

8. Painting, papering and similar finish work.

9. Temporary motion picture, television and theater stage sets and scenery.

10. Window awnings supported by an exterior wall of Group R, Division 3, and Group U Occupancies when projecting not more than 54 inches (1372 mm).

11. Prefabricated swimming pools accessory to a Group R, Division 3 Occupancy in which the pool walls are entirely above the adjacent grade and if the capacity does not exceed 5,000 gallons (18 927 L).

12. [For SFM] State-owned buildings under the jurisdiction of the state fire marshal.
Unless otherwise exempted, separate plumbing, electrical and mechanical permits will be required for the above-exempted items.

Exemption from the permit requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this jurisdiction.

12-1-106.3 Application for Permit.

12-1-106.3.1 Application. *To obtain a permit, the applicant shall first file an application therefor in writing on a form furnished by the code enforcement agency for that purpose. Every such application shall:*

1. Identify and describe the work to be covered by the permit for which application is made.

2. Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.

3. Indicate the use or occupancy for which the proposed work is intended.

4. Be accompanied by plans, diagrams, computations and specifications and other data as

required in Section 12-1-106.3.2.

5. State the valuation of any new building or structure or any addition, remodeling or alteration to an existing building.

6. Be signed by the applicant, or the applicant's authorized agent.

7. Give such other data and information as may be required by the building official.

12-1-106.3.2 Submittal documents. *Plans, specifications, engineering calculations, diagrams, soil investigation reports, special inspection and structural observation programs and other data shall constitute the submittal documents and shall be submitted in one or more sets with each application for a permit. When such plans are not prepared by an architect or engineer, the building official may require the applicant submitting such plans or other data to demonstrate that state law does not require that the plans be prepared by a licensed architect or engineer. The building official may require plans, computations and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such even if not required by state law.*

EXCEPTION: *The building official may waive the submission of plans, calculations, construction inspection requirements and other data if it is found that the nature of the work applied for is such that reviewing of plans is not necessary to obtain compliance with this code.*

12-1-106.3.3 Information on plans and specifications. *Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and all relevant laws, ordinances, rules and regulations.*

Plans for buildings more than two stories in height of other than Group R, Division 3 and Group U Occupancies shall indicate how required structural and fire-resistive integrity will be maintained where penetrations will be made for electrical, mechanical, plumbing and communication conduits, pipes and similar systems.

[For SFM] EXCEPTIONS:

1. Plans and specifications submitted to the Division of the State Architect.

2. Upon the annual submission of a written request by the chief of any city, county, or city and county fire department or fire-protection district to the Division of the State Architect, Office of Regulation Services, approvals required by this subsection shall be obtained from the appropriate chief or his or her authorized representative. In such instances plans and specifications may be submitted to the state fire marshal for relay to the appropriate local authority or may be submitted directly to such local authority.

[For SFM] Movable Walls and Partitions. *Plans or diagrams shall be submitted to the enforcing agency for approval before the installation of, or rearrangement of, any movable wall or partition in any occupancy. Approval shall be granted only if there is no increase in the fire hazard.*

[For SFM] New Construction High-rise Buildings.

1. Complete plans or specifications, or both, shall be prepared covering all work required to comply with new construction high-rise buildings. Such plans and specifications shall be submitted to the enforcing agency having jurisdiction.

2. All plans and specifications shall be prepared under the responsible charge of an architect or a civil or structural engineer authorized by law to develop construction plans and specifications, or by both such architect and engineer. Plans and specifications shall be prepared by an engineer duly qualified in that branch of engineering necessary to perform such services.

Administration of the work of construction shall be under the charge of the responsible architect or engineer except that where plans and specifications involve alterations or repairs, such work of construction may be administered by an engineer duly qualified to perform such services and holding a valid certificate under Chapter 7 (commencing with Section 65700) of Division 3 of the Business and Professions Code for performance of services in that branch of engineering in which said plans, specifications and estimates and work of construction are applicable.

This section shall not be construed as preventing the design of fire-extinguishing systems by persons holding a C-16 license issued pursuant to Division 3, Chapter 9, Business and Professions Code. In such instances, however, the responsibility charge of this section shall prevail.

[For SFM] Existing High-rise Buildings.

1. Complete plans or specifications, or both, shall be prepared covering all work required by Sections 403.11 through 403.25, Title 24, California Code of Regulations, or existing high-rise buildings. Such plans or specifications shall be submitted to the enforcing agency having jurisdiction.

2. When new construction is required to conform with the provisions of these regulations, complete plans or specifications, or both, shall be prepared in accordance with the provisions of this subsection. As used in this section "new construction" is not intended to include repairs, replacements or minor alterations which do not disrupt or appreciably add to or affect the structural aspects of the building.

12-1-106.3.4 Architect or engineer of record.

12-1-106.3.4.1 General. *When it is required that documents be prepared by an architect or engineer, the building official may require the owner to engage and designate on the building permit application an architect or engineer who shall act as the architect or engineer of record. If the circumstances require, the owner may designate a substitute architect or engineer of record who shall perform all of the duties required of the original architect or engineer of record. The building official shall be notified in writing by the owner if the architect or engineer of record is changed or is unable to continue to perform the duties.*

The architect or engineer of record shall be responsible for reviewing and coordinating all submittal documents prepared by others, including deferred submittal items, for compatibility with the design of the building.

12-1-106.3.4.2 Deferred submittals. *For the purposes of this section, deferred submittals are defined as those portions of the design which are not submitted at the time of the application and which are to be submitted to the building official within a specified period. Deferral of any submittal items shall have prior approval of the building official. The architect or engineer of record shall list the deferred submittals on the plans and shall submit the deferred submittal documents for review by the building official. Submittal documents for deferred submittal items shall be submitted to the architect or engineer of record who shall review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and that they have been found to be in general conformance with the design of the building. The deferred submittal items shall not be installed until their design and submittal documents have been approved by the building official.*

12-1-106.3.5 Inspection and observation program. *When special inspection is required by Section 1701, the architect or engineer of record shall prepare an inspection program which shall be submitted to the building official for approval prior to issuance of the building permit. The inspection program shall designate the portions of the work that require special inspection and the name or names of the individuals or firms who are to perform the special inspections, and indicate the duties of the special inspectors.*
The special inspector shall be employed by the owner, the engineer or architect of record, or an agent of the owner, but not the contractor or any other person responsible for the work.

When structural observation is required by Section 1702A, the inspection program shall name the individuals or firms who are to perform structural observation and describe the stages of construction at which structural observation is to occur. The inspection program shall include samples of inspection reports and provide time limits for submission of reports.

12-1-106.4 Permits Issuance.

12-1-106.4.1 Issuance. *The application, plans, specifications, computations and other data filed by an applicant for a permit shall be reviewed by the building official. Such plans may [for SFM] shall be reviewed by other departments of this jurisdiction in accordance with state law, Health and Safety Code Section 13146, in occupancies regulated by the state fire marshal in order to verify compliance with any applicable laws under their jurisdiction. If the building official finds that the work described in an application for a permit and the plans, specifications and other data filed therewith conform to the requirements of this code and other pertinent laws and ordinances, and that the fees specified in Section 12-1-107 have been paid, the building official shall issue a permit there for to the applicant.*

When the building official issues the permit where plans are required, the building official shall endorse in writing or stamp the plans and specifications APPROVED. Such approved plans and specifications shall not be changed, modified or altered without authorizations from the building official, and all work regulated by this code shall be done in accordance with the approved plans.

The building official may issue a permit for the construction of part of a building or structure before the entire plans and specifications for the whole building or structure have been submitted or approved, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holder of a partial permit shall proceed without assurance that the permit for the entire building or structure will be granted.

12-1-106.4.2 Retention of plans. *One set of approved plans, specifications and computations shall be retained by the building official for a period of not less than 90 days from date of completion of the work covered therein; and one set of approved plans and specifications shall be returned to the applicant, and said set shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress.*

12-1-106.4.3 Validity of permit. *The issuance or granting of a permit or approval of plans, specifications and computations shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid.*
The issuance of a permit based on plans, specifications and other data shall not prevent the building official from thereafter requiring the correction of errors in said plans, specifications and other data, or from preventing building operations being carried on there under when in violation of this code or of any other ordinances of this jurisdiction.

12-1-106.4.4 Expiration. *Every permit issued by the building official under the provisions of this code shall expire by limitation and become null and void if the building or work authorized by such permit is not commenced within 180 days from the date of such permit, or if the building or work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 180 days. Before such work can be recommenced, a new permit shall be first obtained to do so, and the fee therefor shall be one half the amount required for a new permit for such work, provided no changes have been made or will be made in the original plans and specifications for such work; and provided further that such suspension or abandonment has not exceeded one year. In order to renew action on a permit after expiration, the permittee shall pay a new full permit fee.*

Any permittee holding an unexpired permit may apply for an extension of the time within which work may commence under that permit when the permittee is unable to commence work within the time required by this section for good and satisfactory reasons. The building official may extend the time for action by the permittee for a period not exceeding 180 days on written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No permit shall be extended more than once.

12-1-106.4.5 Suspension or revocation. *The building official may, in writing, suspend or revoke a permit issued under the provisions of this code whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any of the provisions of this code.*

SECTION 12-1-107 - FEES

12-1-107.1 General. *Fees shall be assessed in accordance with the provisions of this section or shall be as set forth in the fee schedule adopted by the jurisdiction.*

12-1-107.2 Permit Fees. *The fee for each permit shall be as set forth in Table 12-1A.*
The determination of value or valuation under any of the provisions of this code shall be made by the building official. The value to be used in computing the building permit and building plan review fees shall be the total value of all construction work for which the permit is issued, as well as all finish work, painting, roofing, electrical, plumbing, heating, air conditioning, elevators, fire- extinguishing systems and any other permanent equipment.

12-1-107.3 Plan Review Fees. *When submittal documents are required by Section 12-1-106.3.2, a plan review fee shall be paid at the time of submitting the submittal documents for plan review. Said plan review fee shall be 65 percent of the building permit fee as shown in Table 12-1A. The plan review fees specified in this subsection are separate fees from the permit fees specified in Section 12-1-107.2 and are in addition to the permit fees. When submittal documents are incomplete or changed so as to require additional plan review or when the project involves deferred submittal items as defined in Section 12-1-106.3.4.2, an additional plan review fee shall be charged at the rate shown in Table 12-1A.*

12-1-107.4 Expiration of Plan Review*. Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, and plans and other data submitted for review may thereafter be returned to the applicant or destroyed by the building official. The building official may extend the time for action by the applicant for a period not exceeding 180 days on request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.*

12-1-107.5 Investigation Fees: Work without a Permit.

12-1-107.5.1 Investigation. *Whenever any work for which a permit is required by this code has been commenced without first obtaining said permit, a special investigation shall be made before a permit may be issued for such work.*

12-1-107.5.2 Fee. *An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be equal to the amount of the permit fee required by this code. The minimum investigation fee shall be the same as the minimum fee set forth in Table 12-1A. The payment of such investigation fee shall not exempt any person from compliance with all other provisions of this code nor from any penalty prescribed by law.*

12-1-107.6 Fee Refunds. *The building official may authorize refunding of any fee paid hereunder which was erroneously paid or collected. The building official may authorize refunding of not more than 80 percent of the permit fee paid when no work has been done under a permit issued in accordance with this code.*
The building official may authorize refunding of not more than 80 percent of the plan review fee paid when an application for a permit for which a plan review fee has been paid is withdrawn or canceled before any plan reviewing is done. The building official shall not authorize refunding of any fee paid except on written application filed by the original permittee not later than 180 days after the date of fee payment.

[For SFM] Other Fees. *Pursuant to Health and Safety Code Section 13146.2, a city, county or district which inspects a hotel, motel, lodging house, or apartment house may charge and collect a fee for the inspection from the owner of the structure in an amount, as determined by the city, county or district, sufficient to pay its costs of that inspection.*

Pursuant to Health and Safety Code Section 1597.46, Large Family Day-care Homes, the local government shall process any required permit as economically as possible, and fees charged for review shall not exceed the costs of the review and permit process.

Pursuant to Health and Safety Code Section 13217, High-rise Structure Inspection: Fees and Costs, a local agency which inspects a high-rise structure pursuant to Health and Safety Code Section 13217 may charge and collect a fee for the inspection from the owner of the high-rise structure in an amount, as determined by the local agency, sufficient to pay its costs of that inspection.

Pursuant to Health and Safety Code Section 13235, Fire Clearance Preinspection, fee; upon receipt of a request from a prospective licensee of a community care facility, as defined in Section 1502, of a residential-care facility for the elderly, as defined in Section 1569.2, or of a child day-care facility, as defined in Section 1596.750, the local fire enforcing agency, as defined in Section 13244, or state fire marshal, whichever has primary jurisdiction, shall conduct a preinspection of the facility prior to the final fire clearance approval. At the time of the preinspection, the primary fire enforcing agency shall price consultation and interpretation of the firesafety regulations, and shall

notify the prospective licensee of the facility in writing of the specific firesafety regulations which shall be enforced in order to obtain fire clearance approval. A fee of not more than $50.00 may be charged for the preinspection of a facility with a capacity to serve 25 or fewer persons. A fee of not more than $100.00 may be charged for a preinspection of a facility with a capacity to serve 26 or more persons.

The primary fire enforcing agency shall complete the final fire clearance inspection for a community care facility, residential- care facility for the elderly, or child day-care facility within 30 days of receipt of the request for the final inspection, or as of the date the prospective facility requests the final prelicensure inspection by the State Department of Social Services, whichever is later.

Pursuant to Health and Safety Code Section 13235, a preinspection fee of not more than $50 may be charged for a Group R, Division 2 facility with a capacity to serve 25 or less clients. A fee of not more than $100 may be charged for a preinspection of a facility with a capacity to serve 26 or more clients.

Pursuant to Health and Safety Code Section 13131.5, a reasonable final inspection fee, not to exceed the actual cost of inspection services necessary to complete a final inspection may be charged for Group R, Division 2.1 Occupancies classified as residential care facilities for the elderly (RCFE).

Pursuant to Health and Safety Code Section 1569.84, neither the state fire marshal nor any local public entity shall charge any fee for enforcing fire inspection regulations pursuant to state law or regulation or local ordinance, with respect to residential-care facilities for the elderly which service six or fewer persons.

Whenever a local authority having jurisdiction requests that the state fire marshal perform plan review and/or inspection services related to a building permit, the applicable fees for such shall be payable to the Office of the State Fire Marshal.

***SECTION 12-1-108 - INSPECTIONS 12-1-108.1 General.** All construction or work for which a permit is required shall be subject to inspection by the building official and all such construction or work shall remain accessible and exposed for inspection purposes until approved by the building official. In addition, certain types of construction shall have continuous inspection as specified in Section 1701.5. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the permit applicant to cause the work to remain accessible and exposed for inspection purposes. Neither the building official nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection. A survey of the lot may be required by the building official to verify that the structure is located in accordance with the approved plans.*

***12-1-108.2 Inspection Record Card.** Work requiring a permit shall not be commenced until the permit holder or an agent of the permit holder shall have posted or otherwise made available an inspection record card such as to allow the building official to conveniently make the required entries thereon regarding inspection of the work. This card shall be maintained available by the permit holder until final approval has been granted by the building official.*

***12-1-108.3 Inspection Requests.** It shall be the duty of the person doing the work authorized by a permit to notify the building official that such work is ready for inspection. The building official may require that every request for inspection be filed at least one working day before such inspection is desired. Such request may be in writing or by telephone at the option of the building official. It shall be the duty of the person requesting any inspections required by this code to provide access to and means for inspection of such work.*

***12-1-108.4 Approval Required.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the building official. The building official, upon notification, shall make the requested inspections and shall either indicate that portion of the construction is satisfactory as completed, or shall notify the permit holder or an agent of the permit holder wherein the same fails to comply with this code. Any portions which do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the building official. There shall be a final inspection and approval of all buildings and structures when completed and ready for occupancy and use.*

12-1-108.5 Required Inspections.

***12-1-108.5.1 General.** Reinforcing steel or structural framework of any part of any building or structure shall not be covered or concealed without first obtaining the approval of the building official. The building official, upon notification, shall make the inspections set forth in the following subsections.*

***12-1-108.5.2 Foundation inspection.** To be made after excavations for footings are complete and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. All materials for the foundation shallbe on the job, except where concrete is ready mixed in accordance with UBC Standard 19-3, the concrete need not be on the job. Where the foundation is to be constructed of approved treated wood, additional inspections may be required by the building official.*

***12-1-108.5.3 Concrete slab or under-floor inspection.** To be made after all in-slab or under-floor building service equipment, conduit, piping accessories and other ancillary equipment items are in place, but before any concrete is placed or floor sheathing installed, including the subfloor.*

***12-1-108.5.4 Frame inspection.** To be made after the roof, all framing, fire blocking and bracing are in place and all pipes, chimneys and vents are complete and the rough electrical, plumbing, and heating wires, pipes and ducts are approved.*

12-1-108.5.5 Lath or gypsum board inspection. *To be made after all lathing and gypsum board, interior and exterior, is in place, but before any plastering is applied or before gypsum board joints and fasteners are taped and finished.*

12-1-108.5.6 Final inspection. *To be made after finish grading and the building is completed and ready for occupancy.*

12-1-108.6 Special Inspections. *For special inspections, see Chapter 17.*

12-1-108.7 Other Inspections. *In addition to the called inspections specified above, the building official may make or require other inspections of any construction work [for SFM] including, but not limited to, fire protection and detection systems to ascertain compliance with the provisions of this code and other laws which are enforced by the code enforcement agency.*

12-1-108.8 Reinspections. *A reinspection fee may be assessed for each inspection or reinspection when such portion of work for which inspection is called is not complete or when corrections called for are not made. This subsection is not to be interpreted as requiring reinspection fees the first time a job is rejected for failure to comply with the requirements of this code, but as controlling the practice of calling for inspections before the job is ready for such inspection or reinspection. Reinspection fees may be assessed when the inspection record card is not posted or otherwise available on the work site, the approved plans are not readily available to the inspector, for failure to provide access on the date for which inspection is requested, or for deviating from plans requiring the approval of the building official. To obtain a reinspection, the applicant shall file an application therefor in writing on a form furnished for that purpose and pay the reinspection fee in accordance with Table 12-1A or as set forth in the fee schedule adopted by the jurisdiction. In instances where reinspection fees have been assessed, no additional inspection of the work will be performed until the required fees have been paid.*

SECTION 12-1-109 - CERTIFICATE OF OCCUPANCY 12-1-109.1 Use and Occupancy. *No building or structure shall be used or occupied, and no change in the existing occupancy classification of a building or structure or portion thereof shall be made until the building official has issued a certificate of occupancy there for as provided herein.*

EXCEPTION: *Group R, Division 3 and Group U Occupancies.*
Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Certificates presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid.

12-1-109.2 Change in Use. *Changes in the character or use of a building shall not be made except as specified in Section 3405 of this code.*

12-1-109.3 Certificate Issued. *After the building official inspects the building or structure and finds no violations of the provisions of this code or other laws which are enforced by the code enforcement agency, the building official shall issue a certificate of occupancy which shall contain the following:*

1. The building permit number.

2. The address of the building.

3. The name and address of the owner.

4. A description of that portion of the building for which the certificate is issued.

5. A statement that the described portion of the building has been inspected for compliance with the requirements of this code for the group and division of occupancy and the use for which the proposed occupancy is classified.

6. The name of the building official.

12-1-109.4 Temporary Certificate. *If the building official finds that no substantial hazard will result from occupancy of any building or portion thereof before the same is completed, a temporary certificate of occupancy may be issued for the use of a portion or portions of a building or structure prior to the completion of the entire building or structure.*

12-1-109.5 Posting. *The certificate of occupancy shall be posted in a conspicuous place on the premises and shall not be removed except by the building official.*

12-1-109.6 Revocation. *The building official may, in writing, suspend or revoke a certificate of occupancy issued under the provisions of this code whenever the certificate is issued in error, or on the basis of incorrect information supplied, or when it is determined that the building or structure or portion thereof is in violation of any ordinance or regulation or any of the provisions of this code*

TABLE 12-1A-BUILDING PERMIT FEES

TOTAL VALUATION	***FEE***
$1.00 to $500.00	*$21.00*
$501.00 to $2,000.00	*$21.00 for the first $500.00 plus $2.75 for each additional $100.00, or fraction thereof, to and including $2,000.00*
$2,001.00 to $25,000.00	*$62.25 for the first $2,000.00 plus $12.50 for each additional $1,000.00, or fraction thereof, to and including $25,000.00*
$25,001.00 to $50,000.00	*$349.75 for the first $25,000.00 plus $9.00 for each additional $1,000.00, or fraction thereof, to and including $50,000.00*
$50,001.00 to $100,000.00	*$574.75 for the first $50,000.00 plus $6.25 for each additional $1,000.00, or fraction thereof, to and including $100,000.00*
$100,001.00 to $500,000.00	*$887.25 for the first $100,000.00 plus $5.00 for each additional $1,000.00, or fraction thereof, to and including $500,000.00*
$500,001.00 to $1,000,000.00	*$2,887.25 for the first $500,000.00 plus $4.25 for each additional $1,000.00, or fraction thereof, to and including $1,000,000.00*
$1,000,001.00 and up	*$5,012.25 for the first $1,000,000.00 plus $2.75 for each additional $1,000.00, or fraction thereof*
Other Inspections and Fees: *1. Inspections outside of normal business hours (minimum charge-two hours) $42.00 per hour** . . . . . *2. Reinspection fees assessed under provisions of Section 12-1-108.8 $42.00 per hour** . . . . . *3. Inspections for which no fee is specifically indicated (minimum charge-one-half hour) $42.00 per hour** . . . . . *4. Additional plan review required by changes, additions or revisions to plans (minimum charge-one-half hour) $42.00 per hour** . . . . . *5. For use of outside consultants for plan checking and inspections, or both Actual costs***	

**Or the total hourly cost to the jurisdiction, whichever is the greatest. This cost shall include supervision, overhead, equipment, hourly wages and fringe benefits of the employees involved.*

***Actual costs include administrative and overhead costs*

ITEM 24-1 – Committee Recommendations

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(END OF ITEM)

ITEM 24-2

Chapter 12-4-1
STAGE AND PLATFORMS
SMOKE OR HEAT VENTILATORS
STANDARD 12-4-1

STATE FIRE MARSHAL

Smoke or Heat Ventilators

Sec. 12-4-100.

*(a) **Application.** The minimum design, construction, and performance standard set forth herein for stage and platform smoke or heat ventilators are those deemed necessary to establish conformance to the provisions of these regulations.*

*(b) **Scope.** This standard covers ventilators and shutters designed to open under conditions of excessive smoke or heat to provide openings for the release to the atmosphere of accumulated smoke or heat.*
A smoke or heat ventilator covered by this standard consists of a prefabricated frame of metal or other noncombustible materials; a cover of noncombustible, or plastic materials; an automatic releasing device; and the control rigging. The control rigging may include electrically operated units for normal opening and closing.

*(c) **Tested and Listed Component Parts.** Component parts, devices, combinations of devices, and electrical equipment which have been tested and listed by an approved testing agency for the intended purpose need not be individually re-tested. Such individually tested and listed component parts, devices and equipment shall be subjected to the performance standard tests to determine their suitability for use in the smoke or heat ventilator.*

*(d) **Alternate Constructions.** Ventilators having materials or forms of construction differing from this standard may be investigated and tested in accordance with these regulations, and if found to be substantially equivalent in performance may be given recognition for approval.*

*(e) **Marking.** Units shall be provided with a manufacturers label or other permanent markings clearly identifying the manufacturer and model numbers. Plastics in dome-type ventilators shall be identified by brandmarkings, imprint or other markings acceptable to the State Fire Marshal.*

*(f) **Framing Design.** The unit and cover shall be so formed and assembled that they will have the strength and rigidity necessary to resist the abuses to which they are liable to be subject without adversely affecting their performance, and without operational failure due to partial collapse with the resulting reduction of spacings, loosening or displacement of parts, or other serious defects.*

*(g) **Curb Design.** The ventilator design shall include provisions for mounting on roof curbs or shall in themselves incorporate a design to provide the equivalent of roof curbs.*

*(h) **Corrosion Resistant.** Ventilators shall be constructed of corrosion-resistant materials. Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating or other equivalent means. This includes all parts upon which proper mechanical operation may depend. Bearings and hinge points shall be corrosion resistant or of such material and design as to ensure against binding due to corrosion.*
Ventilators designed and constructed in accordance with the above may be accepted without additional tests establishing the effects of frost, expansion by heat or warping of the framework.

*(i) **Plastic Covers.** Plastic covers shall be of the dome type having a continuous curvature with the center not less in height than 10 percent of the span having the least dimension but not less than 5 inches.*

*(j) **Area.** The minimum dimension for an effective vent opening should not be less than 4 feet in any direction. The effective venting area is the minimum cross-sectional area through which smoke and gases must pass in route to the atmosphere. The effective venting area of monitors shall be the cross-sectional area of the throat or the area of the side lights on one side of the monitor, whichever is the lesser. Ventilators having plastic covers shall not exceed 100 square feet in area.*

*(k) **Fail-safe Design.** The ventilator cover, lid, sidelight or shutter shall be designed to fail safe in the event of fire and shall not fall back over the opening. It shall require a manual operation to reclose the cover, lid, sidelight or shutter.*

*(l) **Opening Counterforce.***

1. Gravity-type ventilators shall have securely attached weights to provide a continuous excess counterweight of not less than 30 pounds throughout the opening arc of the lid or sidelight.

2. Devices used to open ventilators shall be designed to exert a continuous opening force, at all times normal to the lid of not less than 30 pounds. When springs are used they shall not be stressed to more than 50 percent of their capacity when the lid is in a closed position.

3. Louvered-type shutters intended for installation in gables shall be of the gravity type. The excess counter-weight shall be not less than 2 pounds per square foot of gross shutter area.

(m) Automatic heat or smoke detectors shall be placed in the underside of the ventilator at or above the roof line.

(n) ***Test Procedure.***
1. Ventilators and shutters shall be mounted for the tests in a manner simulating their intended use. The lid, cover or sidelight shall be held in a closed position by a fusible link, or an automatic heat or smoke actuated detector or combination thereof, and the fusible link or detector controls.

2. The opening counterforce shall be measured at the geometric center of the lid, cover or sidelight. The automatic detector shall be released and measurements of the counterforce taken at various points throughout the opening arc but at not less than at 30 inches and at 60 inches from the plane of the lid when in a closed position, and at a point past 90 inches from the horizontal.

3. The opening force of gable-type shutter ventilators shall be measured from the top of the operating bar.

(o) ***Test Report.*** *The test report shall include but is not limited to the following:*

1. A detailed description of the unit and its intended operation.

2. Engineering data and shop drawings. Shop drawings shall bear the seal or stamp of a registered or licensed engineer or architect attesting to the structural integrity of the ventilator as it relates to the provisions of Section 12-4-100 (f).

3. Photographs (4 inches by 5 inches or larger) of the unit with markings identifying component parts of the unit.

4. Description and results of the tests performed

Chapter 12-7-1
FIRE-RESISTIVE STANDARDS
FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS
STANDARD 12-7-1

STATE FIRE MARSHAL Scope Sec. 12-7-100.

(a) This standard for fire tests contains methods that are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

(b) It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after exposure.

Fire Testing Furnaces and Control Sec. 12-7-101. *Fire testing furnaces and their control shall conform to SFM 12-7-1, Fire Testing Furnaces.*

Unexposed Surface Temperatures Sec. 12-7-102.

(a) ***Thermocouples.*** *Temperatures of unexposed surfaces shall be measured with thermocouples placed under flexible, oven-dry, felted asbestos pads, 6 inches square, 0.4 inch in thickness, and weighing not less than 1.0 nor more than 1.4 pounds per square foot. The pads shall be sufficiently soft so that, without breaking, they may be shaped to contact over the whole surface against which they are placed. The wire leads of the thermocouple shall have an immersion under the pad and be in contact with the unexposed surface for not less than 31/2 inches. The hot junction of the thermocouple shall be placed approximately under the center of the pad. The outside diameter of protecting or insulating tubes shall not be more than 5/16 inch. The pad shall be held firmly against the surface, and shall fit closely about the thermocouples.*
The wires for the thermocouple in the length covered by the pad shall be not heavier than No. 18 B.&S. gage (0.04 inch) and shall be electrically insulated and heat- and moisture-resistant coatings.

NOTE: *In tests of assemblies with roof coverings, the thermocouples and pads shall be placed on top of the roof covering.*

(b) ***Ceiling-Floor, Ceiling-roof Assemblies.*** *Temperature readings shall be taken in the center of the plenum, on the bottom side of the floor or roof deck, and on the structural members in fire- endurance tests of ceiling-floor and ceiling-roof assemblies. Thermocouples shall be located on structural steel as specified in Section 12-7-110 (c). In combustible assemblies five or more thermocouples shall be located on the bottom of soffit of joists or beams. Thermocouples shall be placed in representative locations such as at mid-span, over joints in the ceiling, over light fixtures, over air-outlet openings or similar locations.*

(c) ***Thermocouple Locations on Unexposed Side.*** *Temperature readings shall be taken at not less than nine points on the surface of the unexposed side. Five of these shall be symmetrically disposed, one to be approximately at the center of the specimen and four at approximately the center of its quarter sections. The other four shall be located at the discretion of the testing authority to obtain representative information on the performance of the construction under test. None of the thermocouples shall be located nearer than 11/2 times the thickness of the construction, or nearer than 12 inches to the edges. An exception shall be made in those cases where there is an element of the construction at the edges which is not otherwise represented in the remainder of the construction. Also, none of the thermocouples shall be located opposite or on top of beams, girders, pilasters, or other structural members if temperatures at such points will obviously be lower than at other more representative locations.*

(d) ***Temperature Intervals.*** *Temperature readings shall be taken at intervals not exceeding 15 minutes until a reading exceeding 212? F (100? C) has been obtained at any one point. Thereafter the readings may be taken more frequently at the discretion of the testing body, but the intervals need not be less than five minutes.*

(e) ***Maximum Unexposed Temperature Rise.*** *Where the conditions of acceptance place a limitation on the rise of temperature of the unexposed surface, the temperature end point of the fire endurance period shall be determined by the average of the measurements taken at individual points; except that if a temperature rise 30 percent in excess of the specified limit occurs at any one of these points, the remainder shall be ignored and the fire endurance period judged as ended.*

Classification as Determined by Test Sec. 12-7-103.

(a) ***Fire Exposure Report.*** *Results shall be reported in accordance with the performance tests prescribed in these methods. They shall be expressed in time periods of resistance, to the nearest integral minute. Reports shall include observations of significant details of behavior of the material or construction during the test and after the furnace fire is cut off, including information on deformation, spalling, cracking, burning of the specimen or its component parts, continuance of flaming, and production of smoke. The form and contents of reports shall be in accordance with Section 12-7-115.*

(b) ***Structural Fire Report.*** *Reports of tests involving wall, ceiling-floor, ceiling-roof, or beam constructions in which restraint is provided against expansion, contraction or rotation of the construction shall describe the method used to provide this restraint and include details of the restraining frame as well as information recorded during the test concerning the forces imposed on that structure by the test specimen.*

Test Specimen Sec. 12-7-104.

*(a) **Representative Specimen.** The test specimen shall be truly representative of the construction for which classification is desired, as to materials, workmanship, and details such as dimensions of parts, and shall be built under conditions representative of those obtaining as practically applied in building construction and operations. The physical properties of the materials and ingredients used in the test specimen shall be determined and recorded. When necessary for evaluation of test reports, the sponsor shall furnish them to the enforcing agency.*

*(b) **Specimen Size.** The size and dimensions of the test specimen specified herein are intended to apply for rating constructions of dimensions within the usual general range employed in build ngs. If the conditions of use limit the construction to smaller dimensions, a proportionate reduction may be made in the dimensions of the specimens for a test qualifying them for such restricted use.*

Duration and Conduct of Tests Sec. 12-7-105.

*(a) **Fire Endurance.** The fire endurance test on the specimen with its applied load, if any, shall be continued until failure occurs, or until the specimen has withstood the test conditions for a period equal to that herein specified in the conditions of acceptance for the given type of construction.*

*(b) **Hose Stream Test.** Where required by the conditions of acceptance, a duplicate sample shall be subjected to a fire exposure test for a period equal to one-half of that indicated as the resistance period in the fire endurance test, but not for more than one hour, immediately after which the sample shall be subjected to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, changes in direction being made slowly.*

*(c) **Exemption.** The hose stream shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, of less than one hour.*

*(d) **Optional Program.** The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the sample subjected to the fire endurance test and immediately following the expiration of the fire endurance test.*

*(e) **Stream Equipment and Details.** The stream shall be delivered through 21/2-inch hose, discharging through a National Standard Play Pipe of corresponding size equipped with a 11/8-inch discharge tip of the standard-taper, smooth-bore pattern without shoulder at the orifice. The water pressure and duration of application shall be as specified in Table SFM 12-7-1A.*

*(f) **Nozzle Distance.** The nozzle orifice shall be 20 feet from the center of the exposed surface of the test sample if the nozzle is so located that, when directed at the center, its axis is normal to the surface of the test sample. If otherwise located, its distance from the center shall be less than 20 feet by an amount equal to 1 foot for each 10 degrees of deviation from the normal.*

*(g) **Protection and Conditioning of Test Specimen.** The test specimen shall be protected during and after fabrication to ensure normality of its quality and condition at the time of test. It shall not be tested until a large portion of its final strength has been attained, and, if it contains moisture, until the excess has been removed to achieve an air-dry condition in accordance with the requirements given in Items 1 through 3. The testing equipment and sample undergoing the fire test shall be protected from any condition of wind or weather that might lead to abnormal results. The ambient air temperature at the beginning of the test shall be within the range of 50 to 90? F (10 to 32? C). The velocity of air across the unexposed surface of the sample, measured just before the test begins, shall not exceed 4.4 feet per second, as determined by an anemometer placed at right angles to the unexposed surface. If mechanical ventilation is employed during the test, an air stream shall not be directed across the surface of the specimen.*

1. Prior to the fire test, constructions shall be conditioned with the objective of providing, within a reasonable time, a moisture condition within the specimen approximately representative of that likely to exist in similar constructions in buildings. For purposes of standardization, this condition is to be considered as that which would be established at equilibrium resulting from drying in an ambient atmosphere of 50 percent relative humidity at 73? F. However, with some constructions, it may be difficult or impossi ble to achieve such uniformity within a reasonable period of time. Accordingly, where this is the case, specimens may be tested when the dampest portion of the structure, the portion at 6-inch depth below the surface of massive constructions, has achieved a moisture content corresponding to drying to equilibrium with air in the range of 50 to 75 percent relative humidity at 73 ?5 ? F. In the event that specimens dried in a heated building fail to meet these requirements after a 12-month conditioning period, or in the event that the nature of the construction is such that it is evident that drying of the specimen interior will be prevented by hermetic sealing, these requirements may be waived, except as to attainment of a large portion of final strength, and in the specimen tested in the condition in which it then exists.

2. Specimens shall be exposed to the controlled conditions outlined in Item 1 until the interior or dampest section of the assembly attains a relative humidity of 75 percent or less. If during the conditioning of the specimen it appears desirable or is necessary to use accelerated drying techniques, it is the responsibility of the laboratory conducting the test to avoid procedures which will significantly alter the structural or fire endurance characteristics of the specimen or both from those produced as the result of drying in accordance with procedures given in Item 1.

3. Within 72 hours prior to the fire test, information on the actual moisture content and distribution within the specimen shall be obtained. This information shall be included in the test report.

Tests of Bearing Walls and Partitions Sec. 12-7-106.

*(a) **Size of Sample.** The area exposed to fire shall be not less than 100 square feet with neither dimension less than 9 feet. The test specimen shall not be restrained on its vertical edges. The fire testing furnace, its arrangement and control during fire tests shall conform to SFM 12-7-3, Section 12-7-301 (a), Vertical Large- scale Wall Furnace.*

*(b) **Loading.** During the fire endurance test, and fire and hose stream test, a superimposed lead shall be applied to the construction in a manner calculated to develop theoretically, as nearly as practicable, the working stresses contemplated by the design.*

*(c) **Conditions of Acceptance.** The test shall be regarded as successful if the following conditions are met:*
1. The wall or partition shall have sustained the applied load during the fire endurance test without passage of flame or gases hot enough to ignite conditioned cotton waste, for a period equal to that for which classification is desired.

***NOTE:** Cotton waste shall be conditioned by drying in an oven at a temperature of 120? F for a period of not less than one hour prior to the test.*

2. The wall or partition shall have sustained the applied load during the fire and hose stream test as specified in Section 12-7-105, without passage of flame, of gases hot enough to ignite cotton waste, or passage of the hose stream, and after cooling but within 72 hours after its completion shall sustain the dead lead of the test construction plus twice the superimposed load specified above.

3. Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250? F (139? C) above its initial temperature.

4. Deflection of the wall or partition during the fire endurance test shall not exceed 6 inches. The deflection of specimens varying from the dimensions given in Section 12-7-106 (a) shall be determined proportionately.

Tests of Nonbearing Walls and Partitions Sec. 12-7-107.

*(a) **Size of Sample.** The area exposed to fire shall be not less than 100 square feet, with neither dimension less than 9 feet. The test specimen shall be restrained on all four edges. The fire testing furnace, its arrangement and control during fire tests shall conform to SFM 12-7-3, Section 12-7-301 (a), Vertical Large-scale Wall Furnace.*

*(b) **Conditions of Acceptance.** The test shall be regarded as successful if the following conditions are met:*

1. The wall or partition shall have withstood the fire endurance test without passage of flame or gases hot enough to ignite conditioned cotton waste, for a period equal to that for which classification is desired.

***NOTE:** Cotton waste shall be conditioned by drying in an oven at a temperature of 120? F for a period of not less than one hour prior to the test.*

2. The wall or partition shall have withstood the fire and hose stream test as specified in Section 12-7-105 without passage of flame, of gases hot enough to ignite cotton waste, or passage of the hose stream.

3. Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250? F (139? C) above its initial temperature.

4. Deflection of the wall or partition during the fire endurance test shall not exceed 6 inches. The deflection of specimens varying from the dimensions given in Section 12-7-107 (a) shall be determined proportionately.

Test of Columns Sec. 12-7-108.

*(a) **Size of Sample.** The length of the column exposed to fire shall, when practicable, approximate the maximum clear length contemplated by the design, and for building columns shall be not less than 9 feet. The contemplated details of connections and their protection, if any, shall be applied according to the methods of acceptable field practice.*

*(b) **Loading.***
1. During the fire endurance test, the column shall be exposed to fire on all sides and shall be loaded in a manner calculated to develop theoretically, as nearly as practicable, the working stresses contemplated by the design. Provision shall be made for transmitting the load to the exposed portion of the column without unduly increasing the effective column length.

2. If the submitter and the testing body jointly so decide, the column may be subjected to 13/4 times its designed working load before the fire endurance test is undertaken. The fact that such a test has been made shall not be construed as having had a deleterious effect on the fire endurance test performance.

*(c) **Condition of Acceptance.** The test shall be regarded as successful if the column sustains the applied load during the fire endurance test for a period equal to that for which classification is desired.*

Alternate Test of Protection for Structural Steel Columns Sec. 12-7-109.

*(a) **Application.** This test procedure does not require column loading at any time and may be used at the discretion of the testing laboratory to evaluate steel column protections that are not required by design to carry any of the column load.*

*(b) **Size and Character of Sample.***

1. The size of the steel column used shall be such as to provide a test specimen that is truly representative of the design, materials and workmanship for which classification is desired. The protection shall be applied according to the methods of acceptable field practice. The length of the protected column shall be at least 8 feet. The column shall be vertical during application of the protection and during the fire exposure. The rating of performance shall not be applicable to sizes of columns smaller than those tested.
2. The applied protection shall be restrained against longitudinal temperature expansion greater than that of the steel column by rigid steel plates or reinforced concrete attached to the ends of the steel column before the protection is applied. The size of the plates or amount of concrete shall be adequate to provide direct bearing for the entire transverse area of the protection.

3. The ends of the specimen, including the means for restraint, shall be given sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace.

*(c) **Temperature Measurement.** The temperature of the steel in the column shall be measured by at least three thermocouples located at each of four levels. The upper and lower levels shall be 2 feet from the ends of the steel column, and the other two intermediate levels shall be equally spaced. The thermocouples at each level shall be so placed as to measure significant temperatures of the component elements of the steel section.*

*(d) **Exposure to Fire.** During the fire endurance test, the specimen shall be exposed to fire on all sides for its full length.*

*(e) **Conditions of Acceptance.** The test shall be regarded as successful if the transmission of heat through the protection during the period of fire exposure for which classification is desired does not raise the average (arithmetical) temperature of the thermocouples at any one of the four levels above 1000? F (537.8? C), or does not raise the temperature above 1200? F (648.8? C) at any one of the measured points.*

***Tests of Floors and Roofs Sec. 12-7-110.** (The following is applicable to floors and roofs with or without attached, furred, or suspended ceilings, and requires application of fire exposure to the underside of the construction.)*

*(a) **Size and Construction of Sample.***

1. The area exposed to fire shall be not less than 180 square feet, with neither dimension less than 12 feet. Structural members, if a part of the construction under test, shall lie within the combustion chamber and have a clearance of not less than 8 inches from its walls. No individual classification shall be made of structural members which have a clearance of less than 24 inches from its walls. The fire testing furnace, its arrangement and control during fire tests shall conform to the provisions of SFM 12-7-3, Section 12-7-301 (c), for Horizontal Large-scale Floor Furnace.

2. Structural members forming a part of the assembly shall be supported in accordance with the recommended fabrication procedures for the type of construction. Assemblies representing forms of construction that restrain structural elements and top deck shall be supported by a restraining frame, incorporated in or attachable to the furnace structure in such a manner that comparable restraint shall occur during the test.

*(b) **Loading.** Throughout the fire endurance test, a superimposed load shall be applied to the test specimen. This load, together with the weight of the specimen, shall be as nearly as practicable the maximum theoretical dead and live loads permitted by nationally recognized design standards.*

*(c) **Temperature Measurement.** The temperature of the steel in structural members shall be measured by thermocouples at three or more sections equally spaced along the length of the members with one section located at mid-span; alternately when thermocouples are placed at four sections, they may be at the quarter points provided no thermocouples shall be placed within 24 inches of the furnace walls; except that in cases where the cover thickness is not uniform along the specimen length, at least one of these sections shall include the point of minimum cover. For solid section steel beams, there shall be four thermocouples at each section: one at the center on the exposed face of the bottom flange, one on the edge of the bottom flange, one on the web at the center and one on the bottom at the edge of the top flange. For reinforced or prestressed concrete structural members, thermocouples shall be located on each of the tension reinforcing elements unless there are more than eight elements, in which case, thermocouples shall be placed on eight elements of selected in such a manner as to obtain representative temperatures of all the elements. For designs employing trusses or open-web steel joists, four thermocouples shall preferably be placed at mid-span of each truss or joist, two on the bottom chord, one at the middle of the web element and one on the bottom of the top chord with locations selected in such a manner as to obtain representative temperatures of all the elements provided, however, that no more than four joists need to be so instrumented.*
For designs employing combustible framing, three or more thermocouples shall be placed approximately at mid-span on three or more framing members and so located as to obtain representative temperatures on the soffits of the framing members.

*(d) **Conditions of Acceptance.** In obtaining an assembly classification, the following conditions shall be met:*

1. The construction shall have sustained the applied load during the fire endurance test without passage of flame or gases hot enough to ignite conditioned cotton waste for a period at least equal to that for which classification is desired.

***NOTE:** Cotton waste shall be conditioned by drying in an oven at a temperature of 120? F for a period of not less than one hour prior to the test.*

2. The transmission of heat through the construction during the fire endurance test shall not have been such as to raise the average temperature of the thermocouples on its unexposed surface more than 150? F (139? C) above its initial temperature.

3. Structural failure, deflection or sagging of the structural elements of the test specimen or any portion of the structural elements in excess of 12 inches shall be judged as the end of the fire endurance period.

4. For assemblies employing steel structural members, including decks designed as structural diaphragms the transmission of heat through the protection during the period of fire endurance for which classification is desired does not raise the temperature at any location on the member above 1200? F, nor the average of the thermocouples at any section above 1000? F.

5. For assemblies employing multiple open web steel joists (spaced less than 48 inches on center), the transmission of heat through the protection during the period of fire endurance for which classification is desired does not raise the average of all thermocouples in all joists above 1000? F.

6. For assemblies employing concrete structural members, the transmission of heat through the cover to the steel during the period for which classification is desired does not raise the average temperature of the thermocouples at any section on the steel above 800? F for cold drawn prestressing steel or 1000? F for reinforcing steel.

*(e) **Reports of Results.** The fire endurance shall be reported for the floor or roof assembly as tested, and a different fire endurance classification from that of the assembly for structural members shall not be recorded without reference to Section 12-7-110 (f) and (g).*

*(f) **Alternate Classification Procedure for Loaded Structural Frame Members.** Fire endurance classifications may be developed for structural frame members tested as part of a floor or roof assembly as described in Section 12-7-110 (a) through (c) using the conditions of acceptance described in Section 12-7-110 (g). The fire endurance classification so derived shall be applicable to the structural frame member when used with any floor or roof construction which has a comparable or greater thermal capacity for heat dissipation from the beam, and equal or greater compressive strength than the floor or roof with which it was tested. The fire-resistance classification developed by this method shall not be applicable to sizes of structural frame members smaller than those tested.*

*(g) **Structural Frame Members, Conditions of Acceptance.***

1. The construction shall have sustained the applied load during the fire endurance test for a period equal to that for which classification is desired.

2. For assemblies employing solid steel beams the transmission of heat through the protection during the period of fire endurance for which classification is desired does not raise the temperature at any location on the member above 1200? F, nor the average temperature recorded by four thermocouples at any section above 1000? F.

3. For assemblies employing open-web steel joists or steel trusses spaced 4 feet or more on centers, the transmission of heat through the protection on the steel joists or trusses during the period of fire endurance for which classification is desired does not raise the average temperature of all joists or truss thermocouples above 1000? F.
4. For assemblies employing concrete structural members the transmission of heat through the cover to the steel during the period for which classification is desired does not raise the average temperature of the thermocouples at any section on the steel above 800? F for cold drawn prestressing steel or 1000? F for reinforcing steel.

Tests of Loaded Restrained Structural Frame Members Sec. 12-7-111.

*(a) **Application.** An individual classification of a structural frame member (beams, girders, joists, etc.) may be developed by this test procedure. The structural frame member may be tested with a representative floor or roof section; and the fire endurance classification so derived shall be applicable to the structural frame member when used with any floor or roof construction which has a comparable or greater thermal capacity for heat dissipation from the beam than the floor or roof with which it was tested. The fire endurance classification developed by this method shall not be applicable to sizes of structural frame members smaller than those tested.*

*(b) **Size and Construction of Specimen.** The structural frame member shall be such as to provide a test specimen that is representative of the design, materials and workmanship for which classification is desired. Any protection shall be applied according to the methods of acceptable field practice. The length of the structural frame member exposed to the fire shall be not less than 12 feet and the member shall be tested in a horizontal position. Specimens representing forms of construction in which restraint due to thermal expansion occurs shall be supported by a restraining frame in such a manner that comparable restraint shall occur during the test. A section of a representative floor or roof construction not less than 5 feet wide, symmetrically located with reference to the structural frame member and extending its full length may be included in the test assembly and exposed to fire from below. The floor or roof construction shall not be supported or restrained along its span length or ends.*

*(c) **Furnace.** The fire testing furnace, its arrangement and control during fire tests shall conform to SFM 12-7-3, Fire Testing Furnaces, Section 12-7-301, for the Horizontal Large-scale Floor Furnace, or the Horizontal Large-scale Beam Furnace.*

*(d) **Loading.** Throughout the fire endurance test, a superimposed load shall be applied to the test specimen. This load, together with the weight of the specimen, shall be as nearly as practicable the maximum theoretical dead and live loads permitted by nationally recognized design standards.*

*(e) **Temperature Measurements.** The temperature of the steel in structural members shall be measured by thermocouples at three or more sections spaced along the length of the members with one section located at the mid-span except that in cases where the cover thickness is not uniform along the structural frame member length at least one of these sections shall include the point of minimum cover. For solid steel beams there shall be four thermocouples at each section: one shall be located at the center on the exposed face of the bottom flange: one on the edge of the bottom flange, one on the web at the center and one on the bottom of the top flange. For open-web steel joists there shall be four thermocouples at each section: two on the bottom of the lower chord, one at the middle of the web and one on the bottom of the top chord.*
For trusses there shall be not less than four thermocouples at each section: one on the bottom of the top chord, one at the middle of the nearest diagonal or vertical member and two on the bottom of the lower chord. For reinforced or prestressed concrete structural members, thermocouples shall be located on each of the tension reinforcing elements unless there are more than eight such elements, in which case, thermocouples shall be placed on eight elements selected in such a manner as to obtain representative temperature on all the elements.

*(f) **Conditions of Acceptance.** In deriving a structural frame member classification, the following conditions shall be met:*

1. The structural frame member shall have sustained the applied load during the fire endurance test for a period at least equal to that for which classification is desired.

2. For structural steel members, the transmission of heat through the protection during the period of fire endurance for which classification is desired does not raise the temperature of the thermocouple at any location on the structural steel member above 1200? F nor the average of the thermocouples at any section above 1000? F.

3. For concrete beams, the transmission of heat through the cover to the steel during the period of fire endurance for which classification is desired does not raise the average temperature of the thermocouples at any section on the steel above 800? F for cold drawn prestressing steel or 1000? F for reinforcing steel.

Alternate Test Procedure of Protection for Structural Steel Beams, Girders and Trusses Sec. 12-7-112.

*(a) **Application.** Where the size and construction of the sample, or the loading specified in Sections 12-7-110 (a) and (b) is not feasible by design or dimensions, this alternate test procedure may be used to evaluate the protection for steel beams, girders and trusses without application of design load, provided that the protection is not required by design to function structurally in resisting applied loads. The furnace and its control during fire tests shall conform to SFM 12-7-3, Fire Testing Furnaces, Section 12-7-301, for the Horizontal Small-scale Beam Furnace, the Horizontal Large- scale Beam Furnace or the Horizontal Large-scale Floor Furnace.*

*(b) **Size and Character of Sample.***

1. The size of the steel beam, girder, or truss shall be such as to provide a test specimen that is representative of the design, materials and workmanship for which classification is desired. The protection shall be applied according to the methods of acceptable field practice and the projection below the ceiling, if any, shall be representative of the conditions of intended use. The length of the beam, girder or truss exposed to the fire shall be not less than 7 feet and the member shall be tested in a horizontal position. A section of a representative floor or roof construction not less than 5 feet wide, symmetrically located with reference to the beam, girder or truss and extending its full length, may be included in the test assembly and exposed to fire from below.
The rating of performance shall not be applicable to sizes of solid structural members, or elements of built-up structural members, such as trusses, smaller than those tested.

2. The applied protection shall be restrained against longitudinal expansion greater than that of the steel beam, girder or truss by rigid steel plates or reinforced concrete attached to the ends of the member before the protection is applied. The ends of the member, including the means for restraint, shall be given sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace to the unexposed ends of the member or from the ends of the member to the outside of the furnace.

*(c) **Temperature Measurement.** The temperature of the steel in the beam, girder or truss shall be measured with not less than four thermocouples at each of not less than three sections equally spaced along the length of the beam, girder or truss, symmetrically disposed and not nearer than 2 feet from the inside face of the walls of the furnace. The thermocouples at each section shall be symmetrically placed so as to measure significant temperatures of all component elements of the steel section.*

*(d) **Conditions of Acceptance.** The test shall be regarded as successful if the transmission of heat through the protection during the period of fire exposure for which classification is desired does not raise the average (arithmetical) temperature of the thermocouples at one of the sections above 100? F, or does not raise the temperature above 1200? F at any one of the measured points. The fire-resistance classification so derived shall be applicable to the beam, girder or truss when used with any floor or roof construction which has an equal or greater thermal capacity for heat dissipation from the beam than the floor or roof with which it was tested.*

Tests of Ceiling Constructions Sec. 12-7-113.

*(a) **Application.** This test procedure is to be used for classification of ceilings that are not an integral part of a floor construction and where 36 inches or more space is provided above the top of the joists or beams supporting and protected by the ceiling.*

*(b) **Size of Sample.** The area exposed to fire shall be not less than 180 square feet, with neither dimension less than 12 feet, and the ceiling surface at its edges shall be in contact with the test furnace structure.*

*(c) **Test Construction and Enclosure.** The test ceiling construction shall include all structural members and details including hangers, if any, but not walkways. Above the ceiling during the test, there shall be provided a tight flat-topped enclosure, the underside of the covering material of which shall be 36 inches above the top of the joists or beams supporting and protected by the ceiling. The top of the enclosure shall be made of cement-asbestos board 1/4 inch in thickness under asbestos millboard 1/2 inch in thickness, and the side walls of 8-inch common brick, or it shall be of a construction having equivalent heat conductivity and heat capacity. Where use of the ceiling under a combustible construction is contemplated, at least five 15-inch square panels of 1-inch pine boards shall be attached to the underside of the top of the enclosure. The temperatures on the bottom surface of these panels shall be measured.*

*(d) **Conditions of Acceptance.** The test shall be regarded as successful if the following conditions are met:*

1. The ceiling shall have withstood the fire endurance test without the passage of flame or ignition of combustible members or materials forming part of the construction above the ceilings as evidenced by glow or flame.

2. Transmission of heat through the ceiling during the fire endurance test shall not have been such as to raise the average temperature above the test ceiling more than indicated in Items A, B and C. The limiting temperatures shall be the average of those taken at not less than five points, one of which shall be approximately at the center, and four at approximately the centers of the quarter sections.

A. With combustible supports or other combustible material in contact with the ceiling, the temperature increase at the points of contact shall not exceed 250? F.

B. With combustible supports or other combustible material not in contact with the ceiling, the temperature increase on the surface of any combustible members, pine panels, or combustible material adjacent to the ceiling shall not exceed 250? F. The temperature on the exposed surface of combustible members not in contact with the ceiling shall be measured under a sheet of mica approximately 0.002 inch in thickness.

C. With no combustible material above the ceiling construction, the average temperature measured on the lower surface of the main structural supporting members (beams or slabs) shall not exceed 1200? F and the average temperature of the top and bottom of the beams, when used, shall not exceed 1000? F.

Tests of Protection for Combustible Framing, or for Combustible Facings on the Unexposed Side of Walls, Partitions and Floors Sec. 12-7-114.

*(a) **Character of Sample.** Test panels carrying wall, partition or floor protection shall be finished with the protections which are the subject of the test, except that where the finish on the unexposed side is not the subject of the test and is not specifically indicated, the testing laboratory shall apply a finish judged suitable for the purpose. In case a floor construction, as installed for actual use, is to have no finish on the unexposed side, it shall be so tested.*

*(b) **Size of Sample.** The area exposed to fire shall be, for tests of wall and partition protection, not less than 100 square feet with neither dimension less than 9 feet; for tests of floor protection, not less than 180 square feet with neither dimension less than 12 feet.*

*(c) **Conditions of Acceptance.** The test shall be regarded as successful if the following conditions are met:*

1. The protection shall have withstood the fire endurance test, without ignition of the materials protected, for a period equal to that for which classification is desired.

2. Transmission of heat through the protection during the fire endurance test shall not have been such as to raise the tempera ures at its contact with the protected structural members or facings of the test panel more than 250? F (130? C) above the initial temperatures at these points, except that for members closely embedded on three sides in masonry, concrete or similar noncombustible materials the permissible temperature rise may be 325? F (181? C).

***Standard Fire Endurance Test Report Form Sec. 12-7-115.** Reports of fire endurance tests specified in Section 12-7-103 shall include all data and in the form prescribed in this section.*

*(a) **Cover Page.** Cover page shall include: Laboratory, Laboratory Project Number, Sponsor and Date Tested.*

*(b) **Title Page.** Title page shall include: Table of Contents, Summary of Construction and Fire Endurance Time. The signature of the fire-protection engineer responsible for the conduct of the test may be on the title page or at the conclusion of the report.*

*(c) **Test Facility.** A complete description and details of the furnace and recording equipment shall be provided. This may be in an appendix to the report.*

1. Describe details of end conditions (wedges, bearing, means to prevent rotation), describe details of the restraining frame, degree of restraint or reactive forces opposing expansion and the method used to provide this restraint.
2. If construction is tested under load, indicate how load is applied and controlled (include loading diagram).

3. If construction is tested as nonload bearing indicate whether frame is rigid or moves in test.

(d) ***Description of Materials.*** *Type, size, class, strength, densities, trade name and any additional data necessary to fully define and identify materials. The testing laboratory shall indicate whether materials meet ASTM standards by markings, or by statement of sponsor, or by physical or chemical test by the testing laboratory. The sponsor shall authorize the testing laboratory to provide all data to the enforcing agency as may be necessary for evaluation.*

(e) ***Description of Test Assembly.***

1. Give size of test specimen including dimensions of all parts.

2. Give details of structural design, including safety factor of all structural members in the test assembly.

3. Include plan, elevation, principal cross section, plus other sections as needed for clarity. Detailed drawing of complete assembly.

4. Give details of attachment of test panel in frame.

5. Give location of thermocouples, deflection points and other items for test.

6. Describe general ambient conditions at:

A. Time of construction.

B. During curing (time from construction to test), and

C. Time of test.

7. Record air movement across unexposed face of test specimen.

8. Report relative humidity in specimen.

(f) ***Description of Test.***

1. Except as provided in Section 12-7-102 (d), report temperatures at beginning and every five minutes. If charts are included in report, clearly indicate time and Fahrenheit temperature:

A. In furnace space.

B. On unexposed face for each thermocouple.

C. On protected framing members as stipulated in test method.
In combustible assemblies indicate temperatures on framing back of protection, soffit of joists or other framing members.

D. On request of the enforcement agency, furnish the temperatures in the plenum at mid-depth of ceiling-floor assemblies and underside of floor.

2. Report deflections every 5 minutes for first 15 minutes, and last hour of test. Every 10 minutes in between.

3. Report appearance of exposed face: A. Every 15 minutes, B. At any noticeable development, give details and time, i.e., cracks, buckling, twisting, expansion of supports, flaming, smoke, loss of material, etc., and
C. At end of test include amount of drop out, condition of fasteners, sag, etc.

4. Report appearance of the unexposed face: A. Every 15 minutes, B. At any noticeable development including cracking, smoking, buckling, giving details and time, and C. At end of test.

5. Report time of failure by: A. Temperature rise, B. Failure to carry load, and C. Passage of flame-heat-smoke.

6. If hose stream is required, repeat necessary parts of Items 3 and 5. If failure occurs in hose stream test, describe.

(g) ***Comments by Testing Engineer.***

1. Included shall be a statement concerning construction being representative of field construction. If construction does not represent typical field construction, all deviations shall be noted.

2. If construction is unsymmetrical, clearly indicate face exposed to fire.

3. Fire test.

(h) ***Summary of Results.*** *Shall include:*

1. Endurance time.

2. Nature of failure.

3. Hose stream results.

(i) ***Pictures.*** *Pictures shall be provided as necessary to clarify and show what cannot be covered in the report. Pictures shall include:*

1. Assembly in construction with closeups of details supplementing the report.

2. Exposed face prior to test.

3. Unexposed face at start of endurance test.

4. Unexposed face at end of fire endurance test.

5. Exposed face at end of fire endurance test.

6. If hose stream test is required, repeat Items 1 through 5.

TABLE SFM 12-7-1A-CONDITIONS FOR HOSE STREAM TEST

	WATER PRESSURE AT BASE OF NOZZLE (POUNDS PER SQUARE INCH)	*DURATION OF APPLICATION, MINUTES PER 100 SQUARE FEET OF EXPOSED AREA*
4 hours, and over	*45*	*5*
2 hours, and over, if less than 4	*30*	*21/2*
11/2 hours, and over, if less than 2	*30*	*11/2*
1 hour, and over, if less than 11/2	*30*	*1*
Less than 1 hour, if desired	*30*	*1*

Chapter 12-7-2
FIRE-RESISTIVE STANDARDS
FIRE DAMPERS STANDARD 12-7-2

STATE FIRE MARSHAL Scope Sec. 12-7-200.

(a) These requirements and methods of test apply to fire damper assemblies of various materials and types of construction.

NOTE: *Fire and panic safety standards requires the installation of fire dampers in ducts passing through area separation walls, occupancy separation walls, vertical shaft walls, corridor walls in which openings are required to be fire protected, horizontal exit walls, fire-rated assemblies except those required by reason of the type of construction and air outlet openings in fire-rated ceiling-floor or ceiling-roof assemblies not otherwise qualified by standard full-scale fire tests.*

(b) Tests made in conformity with these test methods will register performance during the fire test exposure, but such tests shall not be construed as determining suitability for use after exposure to fire.

Instructions Sec. 12-7-201.

(a) Approved installation instructions shall be provided by the manufacturer. Instructions shall be illustrated and shall include directions and information adequate for attaining proper and safe installation of the product. Instructions for mounting and for joining with duct material shall be included.

(b) The instructions shall require the use of sleeves with perimeter mounting angles attached to the sleeves on both sides of the wall opening. The connecting ducts shall not be shown as continuous, but shall be shown to terminate at the sleeve. The duct connection to the sleeve shall be provided with S-type slip joints.
Sleeve gages shall conform to the gages fire tested. Sleeves shall not extend beyond the wall opening a distance greater than the area required for the attachment of the retaining angle and S-type slip connection.

EXCEPTION: *The installation instructions for fire dampers tested and listed with integral frame and sleeve of sufficient width to permit direct attachment of perimeter mounting angles on each side of the wall opening are not required to indicate the use of sleeves, provided the gage of the damper frame conforms to the requirements for sleeves.*

(c) Dampers shall be provided by the manufacturer as fire tested except for mounting angles which may be field applied.

Construction Sec. 12-7-202.

(a) Fire dampers shall be constructed so as to provide an effective barrier to air flow when in the closed position. In fire dampers intended for installation in ducts, the vertical through openings at the sides of the blades for operating clearance shall not exceed 1/4 inch, horizontal through openings for operating clearance shall not exceed 1/32 inch. Fire dampers intended for installation in partitions or walls outside of ducts shall have no vertical or horizontal through openings.

NOTE: *A through opening in a damper is a visible opening in the face of the damper when viewed on a plane perpendicular to the mounting plane. (b) Nonmetallic or organic materials used as binders, adhesives, insulation sealants, or finishes may be used if the product otherwise conforms to these requirements.*

(c) Component springs and bearings used in the assembly of a fire damper shall be of material having resistance to atmospheric corrosion equivalent to brass or bronze.

(d) Component springs used in the assembly of a fire damper shall be of material having spring properties equivalent to stainless steel conforming to ASTM A 313-67.

(e) Steel parts used in the assembly shall be provided with corrosion protection equivalent to one of the following corrosion protection systems:

1. Employing stainless steel having resistance to corrosion at least equal to one of the 300 series of stainless steels.

2. Coating of zinc capable of withstanding not less than two dips in a standard copper sulphate solution.

3. Coating of cadmium not less than 0.00050 inch thick.

4. Two coats of good quality finish of the alkyd-resin type or other type outdoor paint. The suitability of the paint may be determined by consideration of its composition or by corrosion tests.

(f) Coated or uncoated metals used in the assembly of fire dampers shall not be used in combination such as to cause detrimental galvanic action which will adversely affect the function of any part of the assembly formed from such material.

(g) A fusible link, other temperature responsive device, smoke or particles of combustion responsive device shall be of an approved type and shall be capable of carrying the imposed load.

Performance Sec. 12-7-203.

(a) The performance of fire dampers shall meet the applicable requirements when tested as described herein. If any indications are observed during the tests that the product will not continue to meet the requirements in normal usage so as to ensure continued safe performance, such supplementary tests shall be conducted as deemed necessary to ensure safe service. Table 12-7-2A indicates the tests applicable to the specific types of fire dampers.

Closing Reliability Test Sec. 12-7-204.

(a) A damper assembly shall close and latch automatically (if latch is provided) from the open position, during each of the 250 operations, and shall throughout this test show no evidence of undue wear, distortion, displacement or rupture of its parts.

(b) Samples representative of the largest and smallest size, style and arrangement of damper assembly shall be subjected to the closing reliability test. Damper assemblies intended for horizontal installation shall be tested in a horizontal plane and not depend on installation in an inclined position for proper operation.

Dust Loading Test Sec. 12-7-205.

(a) A damper assembly shall close and latch automatically (if latch is provided) from the open position following exposure for 7 hours to an air-blown circulating grain-dust air mixture. The grain-dust shall pass through a 100-mesh screen.

(b) Samples representative of each style, and arrangement of damper assembly supported in the position of its intended use shall be tested in a specially constructed test chamber, approximately 5 by 71/2 by 5 feet high, provided with observation windows and with auxiliary equipment to produce a circulating grain dust-air mixture. Nozzles shall be provided to direct the dust-air mixture toward the sample, and the dust particles shall be allowed to accumulate on the various parts of the damper assembly.

Salt-Spray Exposure Test Sec. 12-7-206.

(a) A damper assembly shall close and latch automatically (if a latch is provided) following exposure for a period of five days to salt-spray when tested as described in subsections (b), (c), (d), (e) and (f).

(b) A representative sample of each style and arrangement of damper assembly shall be used for the salt-spray exposure test. Prior to test all grease or oil shall be removed from the test sample, using organic solvents.

(c) The test sample shall be installed in the test chamber with the damper open and supported in the position of its intended use and exposed to the salt spray for a period of five days (120 hours). The temperature of the sample and the test chamber shall be maintained at 95? F (35? C) plus 2? F (1? C) or minus 3? F (2? C) throughout the test period.

(d) The apparatus to be used for salt spray (fog) testing shall consist of a fog chamber having a salt solution reservoir, a supply of suitably conditioned compressed air, a dispersion tower for producing a salt fog, specimen supports, provision for heating the chamber and necessary means of control. The dispersion tower shall be located in the center of the chamber and shall be supplied with salt solution and with warmed, humidified air at a pressure of 17 to 19 pounds per square inch so as to disperse the salt solution in the form of a fine mist or fog throughout the interior of the chamber.

(e) The salt solution shall consist of 20 percent by weight of common salt (sodium chloride) and distilled water. The pH value of this solution as collected after spraying in the test apparatus shall be between 6.5 and 7.2 and the specific gravity between 1.126 and 1.157 at 95? F (35? C).

(f) At the conclusion of the salt-spray exposure, the test sample shall be removed from the chamber and allowed to dry for 24 hours at roof temperature. It shall then be placed in its normal mounting position and on release shall close and latch automatically (if latch is provided).

Spring Closing Force Test Sec. 12-7-207.

(a) A spring-operated damper assembly shall employ a spring or springs capable of exerting a force of 21/2 times that required to close and automatically latch (if a latch is provided) the damper.

(b) A sample representative of each size, style and arrangement of damper assembly shall be subjected to this test. All springs shall be disconnected and the damper assembly placed in the intended operating position.

(c) The force required to close and latch the damper shall be measured by appropriate means at each of a series of positions assumed by the damper from wide open to closed (latched). Force as measured shall be applied through, and at the point of connection of the spring or springs, to the damper blade or operating arm.

(d) Three samples of each spring employed for closing and latching shall be tested for force exerted over the range of extension or compression required for the motion involved in the assembly. The force available from the action of the spring or springs shall be 21/2 times that required for the closing and latching of the damper at any position of travel from wide open to latched.

Zinc Coatings Sec. 12-7-208.

(a) A protective coating of zinc shall be such that a sample of finished galvanized steel parts will not show a fixed deposit of copper after two 1-minute immersions in a standard copper sulphate solution, as described below.

(b) The apparatus consists of a large glass beaker; a chemical, all-glass, mercury thermometer; a watch or clock with a second hand; a standard solution of copper sulphate; a number of clean, dry cheesecloths; and a solvent (carbon tetrachloride of chloroform). It is essential that running tap water be available.

(c) The standard solution of copper sulphate which is to be used in this test is to be made up from distilled water and crystals of chemically pure copper sulphate. In a copper bottle or other suitable container made of copper, a sufficient number of the crystals is to be dissolved in hot distilled water to obtain a solution which has a specific gravity slightly higher than 1.186 after the solution has been cooled to a temperature of 18.3? C (65.0? F). Any free acid which may be present in the solution is to be neutralized by the addition of approximately 1 gram of cupric oxide (CuO) or 1 gram of cupric hydroxide [CU (OH)2] per liter of solution. The solution is then to be diluted with distilled water to obtain a specific gravity of exactly 1.186 at a temperature of 18.3? C (65.0? F). The solution is then to be filtered.

(d) Several 6-inch-long specimens are to be cut and any grease, paraffin, or the like is to be removed by washing the specimens in carbon tetrachloride or chloroform. Each specimen is then to be examined for evidence of damage to the zinc coating, and one which is not damaged is to be selected for use in the test.

(e) The selected specimen is to be rinsed in water and dried with a piece of clean cheesecloth. The surface of the zinc must be perfectly clean before the specimen is immersed in the solution of copper sulphate. Due care must be taken to avoid any contact between the hands or any foreign material and the cleaned surface.

(f) A glass beaker having a diameter equal to at least twice the width of the specimen is to be filled with the standard solution of copper sulphate. The temperature of the solution is to be maintained at 18.3 ?1.1? C (65.0 ?2.0? F). The specimen is to be immersed in the solution and supported on end in the center of the beaker so that not less than 21/2 inches of its length are immersed.
The specimen is to remain in the solution for 60 seconds, during which time it is not to be moved or the solution stirred.

(g) At the end of the 60-second period, the specimen is to be removed from the beaker, rinsed immediately in running tap water, rubbed with clean cheesecloth until any loosely adhering deposits of copper are removed, and is then to be dried with a piece of clean cheesecloth. Again, care is to be taken to avoid contact of the test surface with any foreign objects or the hands. If any part of the surface which was immersed has a bright deposit of firmly adhering metallic copper, an estimate is to be made quickly of the ratio of the area of the covered surface to the area of the total immersed surface, the portion of the specimen within 1/2 inch of the cut end or edges being disregarded.

(h) The immersion, washing, and wiping operation just described is to be repeated successively, using the same portion of the standard solution of copper sulphate, until a bright, firmly adhering deposit of metallic copper remains on the specimen. The specimen is to be subjected to at least one more than the minimum number of such operations required for acceptable performance.

(i) A fixed deposit of metallic copper generally occurs first at the thinnest points in the zinc coating or at those points in the zinc coating where the zinc adheres to the steel less firmly than in others. The area occupied by the fixed deposit increases upon successive dips until the entire zinc coating has disappeared. After the dips have been completed on any one specimen, the portion of the solution of copper sulphate used is to be discarded. A fresh portion of the standard solution is to be employed for each of any succeeding specimens.

(j) The results are to be expressed as an estimate of the percentage of the total immersed surface (excepting the area of the 1/2-inch portion at the cut end or edges) which shows a fixed deposit of copper after each dip, i.e., after the specimen has been dipped, washed, rubbed, dried and then examined. Failure is to be recorded for any part from which a specimen shows a fixed deposit of copper as the result of a number of dips equal to or less than the required number stated in Section 12-7-208 (a).

Cadmium Coatings Sec. 12-7-209.

(a) The thickness of a cadmium coating on the steel parts shall not be less than 0.00050 inch.

(b) The method of determining the thickness of cadmium coatings is the chromic-acid dropping test, conducted as described in the following paragraphs.

(c) The solution to be used for the chromic-acid dropping test is to be made from distilled water and is to contain 200 grams per liter of chemically pure chromic acid, CrO3; and 50 grams per liter of chemically pure concentrated sulfuric acid, H2SO4. (The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H2SO4.)

(d) The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube of approximately 0.025-inch inside bore and 5.5 inches long. The lower end of the capillary tube is tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ?5 drops per minute. If desired, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

(e) The sample and the test solution should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature between 64 and 95? F.

(f) Each sample is to be thoroughly cleaned before testing. All grease and other nonmetallic coatings are to be removed completely by means of suitable solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care should be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

(g) The sample to be tested is to be supported from 0.7 to 1 inch below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested should be inclined about 45 degrees from horizontal.

(h) After cleaning, the sample to be tested is to be put in place under the orifice. The stopcock is to be opened and the time in sec onds is to be measured with a stop watch until the dropping solution dissolves off the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by the change in color at that point.

(i) Each sample of a test lot is to be subjected to the test at three or more points, excluding cut edges and threaded surfaces. If the time required for dissolving off the cadmium coating in the test is not less than that given in Table 12-7-2B, corresponding to the room temperature, the thickness of the coating is considered to comply with the requirement of Section 12-7-209 (a).

Fire Endurance Tests Sec. 12-7-210.

*(a) **Test Assemblies.** The construction, materials, and size of the test fire damper assembly, consisting of single dampers or single dampers installed in a multiple assembly, shall be representative of that for which the damper assembly is to be classified or rated. The size and dimensions of the test specimen and the exposure specified herein are intended to apply for rating of fire damper assemblies within the usual range employed in buildings. The testing agency may, at its discretion, require changes in the proposed installation when, in its judgment, such changes are necessary to obtain representative information on the performance of the construction under test, or when the proposed installation is not representative of those applied in building construction.*

*(b) **Test Installation Fire Dampers in Ducts, Partitions or Walls.** Each test fire damper assembly shall be installed on a Vertical Large-scale Wall Furnace as specified in SFM 12-7-3, Section 12-7-301 (a) in its intended position. If the conditions of use limit the fire damper assembly to smaller dimensions, a proportionate reduction may be made in the dimensions of the fire damper test specimen for a test qualifying them for such restricted use. Such test fire damper assembly shall be installed on a Vertical Half Scale (or larger) Furnace, as specified in SFM 12-7-3, Section 12-7-301 (b) in its intended position.*
Fire dampers intended for use in ducts shall be installed in a sleeve. Fire dampers intended for installation in partitions or walls outside of ducts shall be installed in a frame. For a single fire damper, a sample damper shall be installed with the upstream side facing the furnace. An additional sample shall be installed with the downstream side facing the furnace. If multiple assemblies are tested at one time, the upstream sides or half the individual dampers and the downstream side of the other half of the dampers shall face the furnace. Dampers shall be installed so that there is not less than 6 inches of clearance between the perimeter of the damper and (1) the outer edge of the test panel, and (2) the perimeter of the second sample damper.

*1. **Wall clearances.** Clearances between the fire damper assembly in their sleeves and the masonry opening shall be such that the lap of the mounting angles on the masonry is not less than 1 inch. The installation of the test fire damper assembly shall otherwise be made in accordance with the manufacturer's installation instructions.*

*2. **Masonry settings.** Masonry settings shall be allowed to season at least three days before fire test. Concrete settings shall be allowed to season at least 28 days before fire test.*

*(c) **Test Installation, Fire Dampers in Fire-resisting Ceilings.** Test specimen fire dampers shall be installed in a fire-resisting ceiling floor assembly on a Horizontal Large-scale Floor Furnace as specified in SFM 12-7-3, Section 12-7-301 (c). The area of the ceiling exposed to fire shall be not less than 180 square feet, with neither dimension less than 12 feet. Fire exposure shall be to the underside of the construction.*

1. The ceiling-floor assembly shall be representative of the type of construction (combustible, noncombustible) and the fire endurance time period for which classification is desired, as to materials, workmanship and details such as dimensions of parts, and shall be representative of those obtaining as practically applied in building construction and operation.

2. The number and area of individual fire dampers installed in each 100 square feet of ceiling area shall be representative of that for which the damper assembly is to be classified or rated.

3. Test specimen fire dampers in fire-resisting ceilings shall be mounted in the bottom of the air duct section over the air outlet, or in the throat of the air duct outlet drop with support from the construction above. Subject to the provisions of Section 12-7-210 (a), the installation shall be made in accordance with the manufacturer's proposed installation instructions. Insulation around the duct, if any, or insulation around the air outlet duct drop shall be in accordance with the fire damper manufacturer's instructions.

*4. **Thermocouples.** The thermocouples, their placement and temperature readings shall conform to SFM 12-7-1, Section 12-7-102 (a), "Fire Tests of Building Construction and Materials." Thermocouples shall be placed on structural elements (beams, girders, joists and trusses) as specified in SFM 12-7-1, Section 12-7-110 (c).*

*(d) **Alternate Test Installation, Fire Dampers in Fire-resisting Ceilings.** Test specimen fire dampers shall be installed in a fire-resisting ceiling assembly on a Horizontal Small-scale Furnace as specified in SFM 12-7-3, Section 12-7-301 (d), in its intended position. The net ceiling area exposed to fire shall be not less than 40 square feet, with no dimension less than 5 feet.*

1. Except for openings, the ceiling-floor or ceiling-roof assembly shall be representative of a ceiling-floor or ceiling-roof assembly which has been tested in the Horizontal Large-scale Floor Furnace, SFM 12-7-3, Section 12-7-301 (c), and for which a detailed test report containing temperature readings on the unexposed surface and structural framing members has been issued.

2. The area of the fire damper shall be the maximum area for which the fire damper is to be classified.

3. The test specimen fire damper shall be installed in a representative ceiling-floor or ceiling-roof assembly as indicated in Item 1. The minimum width of exposed ceiling area on two sides of the test specimen shall be not less than 12 inches with a minimum width of exposed ceiling area on the opposite side of not less than 6 inches. The test specimen fire damper shall be mounted in the bottom of a representative duct system over the air outlet, or in the throat of the air duct outlet drop with support from the constructions above. Subject to the provisions of Section 12-7-210 (a), the installation shall be made in accordance with the manufacturer's instructions. Insulation around the duct, if any, or insulation around the air outlet duct drop shall be in accordance with the fire damper manufacturer's proposed installation instructions.

4. Temperature readings shall be taken on the unexposed surface, in the plenum space, on the underside of the floor or roof deck, and on three or more structural members when structural members are contained in the construction. Thermocouples, their placement and temperature readings shall conform to SFM 12-7-1, "Fire Tests of Building Construction and Materials," Sections 12-7-102 and 12-7-110 (c).

(e) The fire test shall be continued until the exposure period for which the damper assembly is to be rated is reached, or until the assembly fails to conform with the conditions of acceptance set forth in Sections 12-7-212 (a), (b), (c) or (d). The exposure period for which the assembly is to be rated shall be determined by test as being either 45 minutes, 1 hour, 11/2 hours, 2 hours or 3 hours.

Hose Stream Test Sec. 12-7-211.

*(a) **Application.** Immediately following the fire exposure portion of the test, when required by the conditions of acceptance, the test assembly shall be subjected to the impact, erosion and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed surface of the damper assembly, changes in direction being made slowly.*

*(b) **Time.** The hose stream shall be delivered through a 21/2-inch hose discharging through a national standard playpipe of corresponding size equipped with a 11/8-inch discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure at the base of the nozzle and duration of application in minutes per 100 square feet of exposed area of the damper assembly shall be as given in Table 12-7-2C.*

*(c) **Distance.** The tip of the nozzle shall be located 20 feet from and on a line normal to the center of the test assembly. If impossible to be so located, the nozzle may be on a line deviating not more than 30 degrees from the line normal to the center of the assembly. When so located, the distance from the center shall be less than 20 feet by an amount equal to 1 foot for each 10 degrees of deviation from the normal.*

Conditions of Acceptance Sec. 12-7-212.

*(a) **Fire Dampers in Duct Systems Passing through Partitions or Walls.***

1. A damper assembly shall remain in the opening during the fire endurance test for the fire exposure period for which it is to be rated and for the hose stream test.

2. All dampers in the test assembly shall close and latch automatically (if a latch is provided) during the first 60 seconds of the fire endurance portion of the test or before the furnace temperature at the fusible element location reaches 285? F (141? C), whichever occurs first. The temperature on the standard time-temperature curve at one minute is 285? F (141? C).

3. During the fire and hose stream test, the movement or warping of any part of the damper assembly shall not result in a visible through opening when viewed on a plane perpendicular to the mounting plane.

4. During the fire endurance and hose stream test, movement or warning of any part of the damper assembly shall not result in through openings between individual parts greater than 3/4 inch during the fire endurance portion of the test, and greater than 1 inch during the hose stream portion of the test.

5. Vertical through openings at the sides of multiblade dampers provided for operating clearances shall not increase in width during the fire endurance and hose stream test.

6. Latching mechanisms, blade shafts in their bearings, interlockingtype damper blades with relation to their guides, and blade guides shall remain engaged and secure during the fire exposure and hose stream test.

*(b) **Fire Dampers in Door, Partitions or Walls outside of Ducts.***

1. A damper assembly shall remain in the opening during the fire endurance test for the fire exposure period for which it is to be rated and for the hose stream test.

2. All dampers in the test assembly shall close and latch automatically (if a latch is provided) during the first 60 seconds of the fire endurance portion of the test or before the furnace temperature at the fusible element location reaches 285? F (141? C), whichever occurs first. The temperature on the standard time-temperature curve at one minute is 285? F (141? C).

3. During the fire and hose stream test, the movement or warping of any part of the damper assembly shall not result in a visible through opening when viewed on a plane perpendicular to the mounting plane.

4. During the fire endurance test, movement or warping of any part of the damper assembly shall not result in visible through openings between individual parts, at the sides, or around the blades as viewed in any direction.

5. During the hose stream test, the movement or warping of any part of the damper assembly shall not result in through openings between individual parts as viewed in any direction greater than one-half the width of blade lap on each other or on blade stops, but shall in no case exceed 1/2 inch.

6. Latching mechanisms, blade shafts in their bearings, interlockingtype damper blades with relation to their guides, and blade guides shall remain engaged and secure during the fire exposure and hose stream test.

(c) ***Fire Dampers in Fire-resisting Ceilings.*** *The ceiling-floor assembly tested in the Horizontal Large-scale Furnace as set forth in SFM 12-7-3, Section 12-7-301 (c), may be rated for fire endurance in accordance with conditions of acceptance set forth in SFM 12-7-1, Section 12-7-110 (d).*

(d) ***Fire Dampers in Fire-resisting Ceilings, Alternate Test Method.*** *Classification of fire damper assemblies for use in fire- resisting ceilings tested in the Horizontal Small-scale Furnace as set forth in SFM 12-7-3, Section 12-7-301 (d), shall be in accordance with the following:*

1. The fire damper assembly, or assemblies, in its frame shall remain in the ceiling opening during the fire endurance test for the fire exposure period for which it is to be rated. Openings in the ceiling assembly shall not result in greater distortion or warping of components, or larger through openings than in the ceiling-floor assembly tested without openings.

2. Transmission of heat through the ceiling-floor assembly during the fire endurance test shall not have been such as to raise he average temperature on its unexposed surface more than 250? F above its initial temperature or more than 325? F at any point.

3. The average temperature of three thermocouples on the bottom surface of combustible framing members in one hour fire endurance rated assemblies shall not exceed 600? F before 30 minutes, or a temperature of 1200? F before 55 minutes. (Criteria based on 2 inches by 10 inches construction grade Douglas fir wood joists spaced 16 inches on center.)

4. The average temperature in any section of solid section structural steel shall not exceed 1000? F and the maximum temperature at any point shall not exceed 1200? F.

5. The average temperature in any section of steel joists (top chord, diagonal web member and bottom chord) shall not exceed 800? F and the maximum temperature at any point shall not exceed 1000? F.

Marking Sec. 12-7-213.

(a) ***Label.*** *Fire damper assemblies shall bear a label issued by an approved listing agency or a label approved by the State Fire Marshal showing the fire-protection rating of the assembly.*

(b) ***Label Markings.*** *The markings on the labels approved by the State Fire Marshal shall include the following:*

1. Name and address of the listee.

2. Model number or type.

3. Symbol, serial or issue number issued by the listing agency, or file number assigned by the State Fire Marshal.

4. Rating of 3, 11/3, 1 or 3/4 hour indicating duration of exposure to fire.

5. The words "Duct," "Wall" or "Ceiling" following the hourly rating designating the location for which the assembly is designed.

TABLE 12-7-2A-TEST FOR FIRE DAMPERS

	FIRE DAMPERS IN OR OUTSIDE OF DUCTS THROUGH WALLS OR PARTITIONS		***FIRE DAMPERS IN OPENINGS THROUGH FIRE-RESISTING CEILINGS***	
	Gravity operated	***Spring operated***	***Gravity operated***	***Spring operated***
(1) Closing Reliability	*X*	*X*	*X*	*X*
(2) Dust Loading	*X*	*X*	*X*	*X*
(3) Salt-Spray Exposure	*X*	*X*	*X*	*X*
(4) Spring Closing Force	–	*X*	–	*X*
(5) Fire Endurance	*X*	*X*	*X*	*X*
(6) Hose Stream	*X*	*X*	–	–

x = Test applicable
- = Test not applicable

TABLE 12-7-2B-CADMIUM COATING DISSOLVE TIME

TEMPERATURE IN DEGREES FAHRENHEIT	***TIME IN SECONDS***
65	*12*
70	*11*
75	*11*
80	*10*
85	*10*
90	*10*
95	*9*

TABLE 12-7-2C-HOSE STREAM TEST

	WATER PRESSURE AT BASE OF NOZZLE, POUNDS PER SQUARE INCH	***DURATION OF APPLICATION, MINUTES PER 100 SQUARE FEET EXPOSED AREA***
3 hours	*45*	*5*
11/2 hours and over if less than 3 hours	*30*	*21/2*
1 hour and over if less than 11/2 hours	*30*	*11/2*

Chapter 12-7-3
FIRE-RESISTIVE STANDARDS
FIRE TESTING FURNACES
STANDARD 12-7-3

STATE FIRE MARSHAL

Scope Sec. 12-7-300. *This standard sets forth the general requirements for the design and control of fire testing furnaces intended for fire exposure testing and assignment of fire endurance ratings of building materials, assemblies of building materials, equipment and devices.*

Furnace Design and Dimensions Sec. 12-7-301. *Furnaces shall consist of a furnace chamber and an insulated specimen frame. The furnace chamber walls and floor shall consist of insulating fire brick or equivalent heat-reflective materials. Furnace dimensions shall be not less than shown in the following:*

(a) ***Vertical Large-scale Wall Furnace.*** *The furnace exposure panel or door shall consist of an insulated steel restraining frame having an available opening for the test sample of not less than 200 square feet in area with neither dimension less than 9 feet.*

(b) ***Vertical Half-scale Wall Furnace.*** *The furnace exposure panel or door shall consist of an insulated steel restraining frame having an available opening of not less than 50 square feet for the test sample. Neither dimension of the furnace opening shall be less than 7 feet.*

(c) ***Horizontal Large-scale Floor Furnace.*** *The furnace exposure panel shall consist of an insulated steel restraining frame having an available opening of not less than 180 square feet for the test sample. Neither dimension of the furnace opening shall be less than 12 feet.*

(d) ***Horizontal Small-scale Furnace.*** *The furnace exposure panel shall consist of an insulated frame having an available opening of not less than 35 square feet for the test sample. Neither dimension of the furnace opening shall be less than 5 feet.*

(e) ***Horizontal Large-scale Beam Furnace.*** *The furnace exposure panel shall consist of an insulated steel restraining frame having an available opening of not less than 180 square feet for the test sample. Neither dimension of the furnace opening shall be less than 5 feet.*

(f) ***Horizontal Small-scale Beam Furnace.*** *The furnace exposure panel for the "Alternate Test of Protection for Structural Steel Beams, Girders and Trusses" shall consist of an insulated steel frame having an available opening of not less than 35 square feet for the test sample. Neither dimension of the furnace opening shall be less than 5 feet.*

(g) ***Column Furnace.*** *The column furnace shall be of such dimensions as to provide an opening for column sections not less than 8 feet in clear length.*

(h) ***Protection of Equipment and Test Specimen.*** *The testing furnaces, equipment and test specimen undergoing the fire test shall be protected from any condition of wind or weather, that might lead to abnormal results. The ambient air temperature of the testing room at the beginning of the test shall be within the range of 50? F to 90? F (10? C to 32? C). Velocity of air across the unexposed face of the test specimen shall not exceed 4.4 feet per second, as determined by an anemometer placed at right angles to the unexposed surface, measured before or during the test. If mechanical ventilation is employed during the test, an airstream shall not be directed across the surface of the specimen.*

Burners and Fuel Sec. 12-7-302.

(a) ***Burners.***

1. In vertical furnaces, burners shall be placed in the back wall of the furnace. The location of the burners and provisions for combustion air shall be such as to provide an even flame exposure to the entire exposed face of the test specimen. Combustion air openings shall be provided in such a manner as to normally prevent induction of combustion air through any opening in the test specimen.

2. In horizontal furnaces, burners shall be placed in the floor or side walls. Burrs and the provisions for combustion air shall be so arranged as to provide a uniform exposure to the entire exposed face of the test specimen.

3. In column furnaces, burners shall be placed in the four walls to provide an even luminous flame exposure to all sides of the test sample.

(b) ***Fuel.*** *Furnaces shall be supplied with natural, manufactured or bottled gas.*

Time-temperature Curve Sec. 12-7-303. *The conduct of fire tests of materials, assemblies, methods of construction, equipment and devices shall be controlled to conform to the applicable portion of the standard time- temperature curve shown in Figure 12-7-3-1. The points on the curve that determine its character are:*
1000? F (538? C) at 5 minutes
. . . . . .
1300? F (704? C) at 10 minutes
. . . . . .
1500? F (843? C) at 30 minutes
. . . . . .
1700? F (927? C) at 1 hour
. . . . . .

1792? F (978? C) at 11/2 hours
. . . . . .
1850? F (1010? C) at 2 hours
. . . . . .
1925? F (1052? C) at 3 hours
. . . . . .
2000? F (1093? C) at 4 hours.
. . . . . .
For a closer definition of the time-temperature curve, see Table 12-7-3A.

Furnace Control Sec. 12-7-304.

(a) ***Thermocouples.***

1. Furnace thermocouples shall be protected by sealed porcelain tubes having 3/4-inch outside diameter and 1/8-inch wall thickness, or, as an alternate, in the case of base-metal thermocouples, shall be protected by 1/2-inch wrought steel or wrought iron pipe of standard weight or equivalent protection of approved type.
The exposed length of the pyrometer tube and thermocouple in the furnace chamber shall be not less than 12 inches.

2. In the large-scale horizontal floor and vertical wall furnaces, the temperature of the fire test exposure shall be deemed to be the average temperature obtained from the readings of not less than nine thermocouples symmetrically disposed and distributed to show the temperature near all parts of the test specimen. In the vertical half scale and horizontal small-scale furnaces, the number of thermocouples shall be proportioned to those of the large-scale furnaces, but shall in no case be less than four thermocouples.

3. In the column furnace, the temperature of the fire test exposure shall be deemed to be the average temperature obtained from the readings of not less than eight thermocouples symmetrically disposed at two levels to show the temperature near all parts of the test specimen. The two levels shall be located approximately 2 feet from the top and bottom of an 8 foot clear height furnace.

4. In the vertical wall furnaces, the junction of the thermocouples shall be placed 6 inches from the exposed face of the test specimen at the beginning of the test. The junction of the thermocouples shall, during the fire test and as a result of deflection, be maintained at 6 inches from the exposed face of the test specimen.

5. In horizontal beam, floor and roof furnaces having a furnace chamber not less than 180 square feet in area, the junction of the thermocouples shall be 12 inches from the exposed face of the test specimen at the beginning of the test, and shall not touch the test specimen during the test as a result of its deflection.

6. In horizontal beam, floor and roof furnaces having a furnace chamber less than 180 square feet in area, the junction of the thermocouples shall be placed 6 inches from the exposed face of the test specimen at the beginning of the test and, during the test, shall not touch the test specimen as a result of its deflection.

(b) ***Temperature Recording.*** *The furnace temperatures shall be read at intervals not exceeding 5 minutes during the first 2 hours, and thereafter the intervals may be increased to not more than 10 minutes.*

(c) ***Furnace Control Accuracy.*** *The accuracy of the furnace control shall be such that the area under the time-temperature curve, obtained by averaging the results from the thermocouple readings, is within 10 percent of the corresponding area under the standard time-temperature curve for fire tests of 1 hour or less duration, within 7.5 percent for those over 1 hour and not more than 2 hours, and within 5 percent for tests exceeding 2 hours in duration. Individual thermocouple readings shall not exceed or fall below the standard time-temperature curve by more than 15 percent.*

(d) ***Furnace Correction.*** *When the indicated resistance period is 1/2 hour or over, determined by the average or maximum temperature rise on the unexposed surface or within the test sample, or by failure under load, a correction shall be applied for variation of the furnace exposure from that prescribed, where it will affect the classification, by multiplying the indicated period by two-thirds of the difference in area between the curve of average furnace temperature and the standard curve for the first three-fourths of the period and dividing the product by the area between the standard curve and a base line of 60? F (20? C) for the same part of the indicated period, the latter area increased by 54 Fahr-hour or 30 Cent- hour (3240 Fahr-minutes or 1800 Cent-minutes) to compensate for the thermal lag of the furnace thermocouples during the first part of the test. For fire exposure in the test higher than standard, the indicated resistance period shall be increased by the amount of the correction and be similarly decreased for fire exposure below standard.*

NOTE: *The correction can be expressed by the following formula:*

$$C = 1 \; (A - AS) \div (AS - L)$$

WHERE:
C = correction in the same units as 1 1 = indicated fire endurance period A = area under the curve of indicated average furnace temperature for the first three-fourths of the indicated period AS = area under the standard furnace curve for the same part of the indicated period L = lag correction in the same units as A and AS (54 Fahr- hour or 30 Cent-hour-3240 Fahr-minutes or 1800 Cent-minutes)

(e) ***Furnace Pressure.*** *The pressure in the furnace chamber during the fire test shall be maintained as nearly equal to atmospheric pressure as possible. Horizontal furnaces may be operated at a slight negative pressure sufficient to reduce haze permitting visual observation. Furnace stacks shall be equipped with dampers to facilitate maintenance of furnace pressure.*

Correlation Sec. 12-7-305. *Tests of specific assemblies of materials shall be conducted for correlation (or correlation factor) of furnace exposure by comparison with tests of identical assemblies and materials conducted in furnaces of "Approved Listing Agencies" which furnaces are deemed as conforming to the design and operating requirements of this standard. Correlation tests of wall furnaces shall include tests of two assemblies, one combustible and one noncombustible. Correlation tests of horizontal furnaces dependent on intended test specimens shall include at least one test for each type of assembly such as combustible ceiling-floor assembly, noncombustible assembly having a high thermal capacity floor for heat dissipation, noncombustible assembly having an insulating concrete floor or other type of design.*

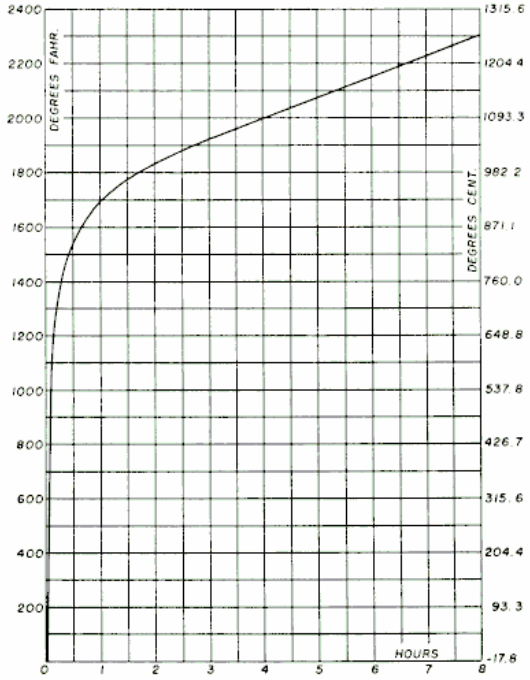
Comparison of test results shall provide evidence of equivalent exposure based on transmitted temperatures on the unexposed side, on structural framing members, on the underside of floor or roof decks, and in the plenum space.

TABLE 12-7-3A-STANDARD TIME-TEMPERATURE CURVE FOR CONTROL OF FIRE TESTS

TIME	AREA ABOVE 68? F BASE						AREA ABOVE 20? C BASE					
	TEMPERATURE											
	Fahr.		Fahr. Min		Fahr. Hour		Cent.		Cent. Min		Cent Hour	
0:00		68		00		0		20		00		0
0:05	1	000	2	330		39		538	1	290		22
0:10	1	300	7	740		129		704	4	300		72
0:15	1	399	14	150		236		760	7	860		131
0:20	1	462	20	970		350		795	11	650		194
0:25	1	510	28	050		468		821	15	590		260
0:30	1	550	35	360		589		843	19	650		328
0:35	1	584	42	860		714		862	23	810		397
0:40	1	613	50	510		842		878	28	060		468
0:45	1	638	58	300		971		892	32	390		540
0:50	1	661	66	200	1	103		905	36	780		613
0:55	1	681	74	220	1	237		916	41	230		637
1:00	1	700	82	330	1	372		927	45	740		762
1:05	1	718	90	540	1	509		937	50	300		838
1:10	1	735	98	830	1	647		946	54	910		915
1:15	1	750	107	200	1	767		955	59	560		993
1:20	1	765	115	650	1	928		963	64	250	1	071
1:25	1	779	124	180	2	070		971	68	990	1	150
1:30	1	792	132	760	2	213		978	73	760	1	229
1:35	1	804	141	420	2	357		985	78	560	1	309
1:40	1	815	150	120	2	502		991	83	400	1	390
1:45	1	826	158	890	2	648		996	88	280	1	471
1:50	1	835	167	700	2	795	1	001	93	170	1	553
1:55	1	843	176	550	2	942	1	006	98	080	1	635
2:00	1	850	185	440	3	091	1	010	103	020	1	717
2:10	1	862	203	330	3	389	1	017	112	960	1	882
2:20	1	875	221	330	3	689	1	024	122	960	2	049
2:30	1	888	239	400	3	991	1	031	133	040	2	217
2:40	1	900	257	720	4	295	1	038	143	180	2	386
2:50	1	912	276	110	4	602	1	045	153	390	2	556
3:00	1	925	294	610	4	910	1	052	163	670	2	728
3:10	1	938	313	250	5	221	1	059	174	030	2	900
3:20	1	950	332	000	5	533	1	066	184	450	3	074
3:30	1	962	350	890	5	848	1	072	194	940	3	249
3:40	1	975	369	890	6	165	1	079	205	500	3	425
3:50	1	988	389	030	6	484	1	086	216	130	3	602
4:00	2	000	408	280	6	805	1	093	226	820	3	780
4:10	2	012	427	670	7	128	1	100	237	590	3	960
4:20	2	025	447	180	7	453	1	107	248	430	4	140
4:30	2	038	466	810	7	780	1	114	259	340	4	322
4:40	2	050	486	560	8	110	1	121	270	310	4	505
4:50	2	062	506	450	8	441	1	128	281	360	4	689
5:00	2	075	526	450	8	774	1	135	292	470	4	874
5:10	2	088	546	580	9	110	1	142	303	660	5	061
5:20	2	100	566	840	9	447	1	149	315	910	5	248
5:30	2	112	587	220	9	787	1	156	326	240	5	437
5:40	2	125	607	730	10	129	1	163	337	630	5	627
5:50	2	138	628	360	10	473	1	170	349	090	5	818
6:00	2	150	649	120	10	819	1	177	360	620	6	010
6:10	2	162	670	000	11	167	1	184	372	230	6	204
6:20	2	175	691	010	11	527	1	191	383	900	6	398
6:30	2	188	712	140	11	869	1	198	395	640	6	594
6:40	2	200	733	400	12	223	1	204	407	450	6	791
6:50	2	212	754	780	12	580	1	211	419	330	6	989
7:00	2	225	776	290	12	938	1	218	431	270	7	188
7:10	2	238	797	920	13	299	1	225	443	290	7	388
7:20	2	250	819	680	13	661	1	232	455	380	7	590
7:30	2	262	841	560	14	026	1	239	467	540	7	792
7:40	2	275	863	570	14	393	1	246	479	760	7	996
7:50	2	288	885	700	14	762	1	253	492	060	8	201

8:00	*2*	*300*	*907*	*960*	*15*	*133*	*1*	*260*	*504*	*420*	*8*	*407*

FIGURE 12-7-3-1-TIME-TEMPERATURE CURVE
FIGURE 12-7-3-1



Chapter 12-7-4
FIRE-RESISTIVE STANDARDS
FIRE DOOR ASSEMBLY TESTS
STANDARD 12-7-4

STATE FIRE MARSHAL

Scope Sec. 12-7-400.

(a) ***Application.*** *These methods of fire tests are applicable to door assemblies of various materials and types of construction for use in wall openings to retard the passage of fire (flame, heat and smoke).*

(b) ***Performance.*** *Tests made in conformity with these test methods will register performance during the test exposure, but such tests shall not be construed as determining suitability for use after exposure to fire.*

(c) ***Suitability of Assemblies.*** *It is the intent that tests made in conformity with these test methods will develop data to enable enforcing agencies to determine the suitability of door assemblies for use in locations where fire resistance of a specified duration is required.*

Fire Testing Furnaces and Control Sec. 12-7-401.

(a) ***Furnaces.*** *Fire testing furnaces and their control shall conform to SFM 12-7-3, Fire Testing Furnaces, Section 12-7-301 (a), Vertical Large-scale Wall Furnaces.*

(b) ***Half Scale.*** *If the proposed conditions of use limit the construction to smaller dimensions, and for the evaluation of hardware intended for use on doors not exceeding 4 feet in width by 7 feet 2 inches in height, fire testing furnaces conforming to Section 12-7-301 (b), Vertical Half-scale Wall Furnace, may be utilized. Constructions and hardware for ceiling access doors intended for use in fire-endurance rated ceiling-floor assemblies shall be tested in furnaces conforming to SFM 12-7-3, Section 12-7-301 (b), (d) or (f).*

Unexposed Surface Temperatures Sec. 12-7-402.

(a) ***Temperatures Recorded.*** *The unexposed surface temperatures of all fire door assemblies shall be recorded. The unexposed surface temperature shall be determined in the manner specified in Sections 12-7-402 (b), (c) and (d).*

(b) ***Surface Temperature Locations.*** *Unexposed surface temperatures shall be taken at not less than three points, with at least one thermocouple in each 16 square foot area of the door(s). Thermocouples shall not be located over reinforcements extending through the door, over glass panels or nearer than 12 inches from the edge of the door.*

(c) ***Thermocouples.*** *Unexposed surface temperatures shall be measured with thermocouples placed under flexible, oven-dry, felted asbestos pads of the following approximate dimensions and weight: 6 inches square, 0.40 inch in thickness, and weighing 0.026 pound. The pads shall be held firmly against the surface of the door(s) and shall fit closely about the thermocouples without breaking. The thermocouple leads shall be immersed under the pad for distance of not less than 31/2 inches, with the hot junction under the center of the pad. The thermocouple leads under the pads shall be not heavier than No. 18 B.&S. gage (0.04 inch) and shall be electrically insulated with heat-resistant and moisture-resistant coatings.*

(d) ***Recording Interval.*** *Unexposed surface temperatures shall be read at the same intervals as used for the furnace temperatures, Section 12-7-304 (b).*

Test Assemblies Sec. 12-7-403.

(a) ***Construction and Size.***

1. The construction and size of the test fire door assembly, consisting of single doors, doors in pairs, special purpose doors (such as dutch doors, double egress doors, etc.) or multisection doors shall be representative of that for which classification or rating is desired. The materials and construction of the door and frame, and the details of the installation, hardware, hangers, guides, trim, finish, and clearance or lap shall be recorded to ensure positive identification or duplication in all respects.

2. A floor structure shall be provided as part of the opening to be protected, except where such floor interferes with the operation of the door. The floor segment shall be of noncombustible material and shall project into the furnace approximately twice the thickness of the test door.

(b) ***Mounting of Doors for Test Purposes.***
1. Swinging doors shall be mounted so as to open into the furnace chamber, except doors in pairs swinging in opposite directions shall be mounted so as to have one door leaf open into and one door leaf open away from the furnace chamber.

2. Sliding and rolling doors, except passenger elevator shaft doors, shall be mounted on the exposed side of the opening in the wall closing the furnace chamber.

3. Passenger elevator shaft doors shall be mounted on the unexposed side of the opening in the wall closing the furnace chamber.

4. Access-type door and chute-type door and frame assemblies shall be mounted so as to have one assembly open into the furnace chamber and another assembly open away from the furnace chamber. Ceiling access doors and frame assemblies shall be mounted in a representative ceiling with the room side of the access door opening into the furnace chamber.

5. Dumbwaiter and service counter door and frame assemblies shall be mounted on the exposed side of the opening in the wall.

6. Door frames shall be evaluated when mounted so as to have the doors open either away from or into the furnace chamber at the discretion of the enforcing agency to obtain representative information on the performance of the construction under test.

7. Surface-mounted hardware (fire exit devices) for use on fire doors shall be evaluated by being installed on one door assembly swinging into the furnace chamber and another door assembly swinging away from the furnace chamber.

8. The mounting of all doors shall be such that they fit snugly within the frame, against the wall surfaces, or in guides, but such mounting shall not prevent free and easy operation of the test door.

9. Clearances for swinging doors shall be (with a minus 1/16-inch tolerance) as follows: 1/8 inch along the meeting edge of doors in pairs, 3/8 inch at the bottom edge of single swing doors and 1/4 inch at the bottom edge of a pair of doors.

10. Clearances for horizontal sliding doors not mounted within guides (with a minus 1/8 inch tolerance) shall be as follows: 1/2 inch between door and wall surfaces, 3/8 inch between door and floor structure and 1/4 inch between the meeting edges of center parting doors. A minimum lap of 4 inches of the door over the wall opening at sides and top shall be provided.

11. Clearances for vertical sliding doors moving within guides (with a minus 1/8-inch tolerance) shall be as follows: 1/2 inch between door and wall surfaces along the top and/or bottom door edges with guides mounted directly to the wall surface, and 3/16 inch between meeting edges of biparting doors or 3/16 inch between door and floor structure or sill.

12. Clearances for passenger elevator sliding doors (with a minus 1/8-inch tolerance) shall be as follows: 3/8 inch between door and wall surfaces and 3/8 inch between multisection door panels.
Multisection door panels shall overlap 3/4 inch. Door panels shall lap the wall opening 3/4 inch at the sides and top.

Conduct of Tests Sec. 12-7-404.

(a) ***Time of Testing.*** *Masonry settings shall be allowed to dry at least three days before tests are made.*

(b) ***Fire Endurance Test.***

1. The pressure in the furnace chamber shall be maintained as nearly equal to the atmospheric pressure as possible.

2. The test shall be continued until the exposure period of the desired classification or rating is reached, unless the conditions of acceptance set forth in the appropriate paragraphs are exceeded in a shorter period.

(c) ***Hose Stream Test.***

1. Immediately following the fire endurance test, the test assembly shall be subjected to the impact, erosion and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed surface, changes in direction being made slowly.

2. The hose stream shall be delivered through a 21/2 inch hose discharging through a national standard play-pipe of corresponding size equipped with a 11/8 inch discharge tip of the standard- taper smooth-bore pattern without shoulder at the orifice. The water pressure at the base of the nozzle and duration of the application in seconds per square feet of exposed area shall be as given in Table 12-7-4A.

3. The tip of the nozzle shall be located 20 feet from and on a line normal to the center of the test door. If impossible to be so located, the nozzle may be on a line deviating not more than 30 degrees from the line normal to the center of the test door. When so located the distance from the center shall be less than 20 feet by an amount equal to 1 foot for each 10 degrees of deviation from the normal.

Report Sec. 12-7-405.

1. The report shall record the construction and mounting details of the door(s) as provided in Section 12-7-403. Drawings and photographs of construction and mounting details shall be provided.

2. The results shall be reported in accordance with the performance in tests prescribed in these test methods. The report shall show the performance under the desired exposure period chosen from the following: 20 minutes, 30 minutes, 45 minutes, 1 hour, 11/2 hours or 3 hours. The report shall include the temperature measurements of the furnace, and, if determined, of the unexposed side of the test assembly. It shall also contain a record of all observations having a bearing on the performance of the test assembly.

Conditions of Acceptance Sec. 12-7-406.

(a) ***General.***

1. A door assembly shall be considered as meeting the requirements for acceptable performance when it remains in the opening during the tests specified in this standard within the limitations contained in this section for the desired endurance rating.

2. The test assembly shall have withstood the fire endurance test and hose stream test without developing openings anywhere through the assembly, except that dislodging of small fragments from the central area of the glass light shall be disregarded. The edges of the individual glass light shall remain in place.

***EXCEPTION:** The hose stream test shall not be required for opposite swing double egress exit doors, and for doors of fire endurance rating of less than 45 minutes with or without approved wired glass lights.*

3. Flaming on the unexposed surface of a door assembly shall not be permitted during the first 30 minutes of the classification periods. Some intermittent light flames (tongues of flame not exceeding approximately 6 inches in length) for periods not exceeding five-minute intervals are permissible along the edges of door after 30 minutes. During the last 15 minutes of the classification period the unexposed surface area of the door covered by light flaming or charring shall be contained within a distance of 11/2 inches from a vertical door edge and within 3 inches from the top edge of the door.

***EXCEPTION:** On doors not subjected to the hose stream test, finished with surface veneers or crossbands and veneers, surface flaming on the unexposed surface shall not burn or char crossbands or surface veneer along the hinge or latch jamb and shall not burn or char crossbands or surface veneer down more than 1/2-inch from the top edge, except that light browning without any flaming may occur at throughbolts and the latch rose.*

*(b) **Hardware.** When hardware is to be evaluated for use on fire doors, it shall hold the door closed under the conditions of acceptance for an exposure period of three hours, and the latch bolts shall remain projected and shall be intact after the test. Builders fire door hardware shall not be equipped with any dogging device, set screw or other arrangement which can be used to prevent projection and latching of the latch bolt, locking device or locking bolt upon closing of the door(s). The hardware need not be operable after the test. All parts essential to the latching or unlatching of fire exit hardware devices shall be constructed of materials having a solidus temperature of not less than 1000˚F.*

*(c) **Swing Doors.***

1. The movement of swing doors shall not permit any portion of the edges to move from the original position in a direction perpendicular to the plane of the door more than the thickness of the door during the first half of the classification period, nor more than 27/8 inches during the entire classification period and as a result of the hose stream.

2. The movement of swing doors mounted in pairs shall not permit any portion of the meeting edges to move more than the thickness of the door away from the adjacent door edge in a direction perpendicular to the plane of the doors during the entire classification period and as a result of the hose stream.

3. An assembly consisting of a pair of swinging doors, incorporating an astragal shall not separate in a direction parallel to the plane of the doors more than 3/4 inch not equal to the throw of the latch bolt along the meeting edges.

4. An assembly consisting of a pair of swinging doors, without an overlapping astragal, for a fire and hose stream exposure of 11/2 hours or less, shall not separate along the meeting edges more than 3/8 inch, including the initial clearance between doors.

5. An assembly consisting of a single swinging door shall not separate more than 1/2 inch at the latch location.

6. Door frames to be evaluated with doors shall remain securely fastened to the wall on all sides and shall not cause through openings between frame and doors or between frame and adjacent wall.

*(d) **Sliding Doors.***

1. Doors mounted on the face of the wall shall not move from the wall sufficiently to develop a separation of more than 21/8 inches at the point of separation during the entire classification period and as a result of the hose stream.

2. Doors mounted in guides shall not release from guides and guides shall not loosen from fastenings.

3. The bottom bar of rolling steel doors shall not separate from the floor structure more than 3/4 inch during the entire classification period and as a result of the hose stream.

4. The meeting edge of centerparting horizontal sliding doors and biparting vertical sliding doors shall not separate more than the door thickness in a direction perpendicular to the plane of the doors.

5. The meeting edges of centerparting horizontal sliding doors and biparting vertical sliding doors without an overlapping astragal for a fire and hose stream exposure of 11/2 hours or less shall not separate along the meeting edges more than 3/8 inch, including the initial clearance between doors.

6. The meeting edges of centerparting horizontal sliding doors incorporating an astragal shall not separate in a direction parallel to the plane of the doors more than 3/4 inch nor equal to the throw of the latch bolt along the meeting edges.

7. The bottom edge of service counter doors or single slide dumbwaiter doors shall not separate from the sill more than 3/8 inch.

8. A resilient astragal when required for life-safety purposes shall not deteriorate sufficiently to cause through openings during the fire endurance part of the test, but small portions may be dislodged during the hose stream part of the test.

9. The lap edges of passenger elevator doors, including the lap edges of multisection doors, shall not move from the wall or adjacent panel surfaces sufficiently to develop a separation of more than 27/8 inches at the point of separation during the entire classification period and as a result of the hose stream.

10. The meeting edges of centerparting passenger elevator door assemblies, for a fire and hose stream exposure of 11/2 hours or less, shall not move apart more than 11/4 inches as measured in any horizontal plane during the entire classification period and as a result of the hose stream.

Marking Sec. 12-7-407.

(a) ***Label.*** *Fire assemblies shall bear a label issued by an approved listing agency or a label approved by the State Fire Marshal showing the fire-protection rating of the assembly.*

(b) ***Label Markings.*** *The markings on the labels approved by the State Fire Marshal shall include the following:*

1. Name and address of the listee.

2. Model number or identification of the assembly.

3. Serial number assigned by the listing agency or file number assigned by the State Fire Marshal.

4. Rating of 3, 11/3, 1, 3/4, 1/2 or 1/3 hour indicating duration of exposure to fire.

5. Letter A, B, C, D or E following the hourly rating designating the location for which the assembly is designed.

6. Temperature rise on the unexposed fact at the end of 30 minutes. Temperature rise classification shall be 250´F max., 450´F max., 650´F max. or no reference on the label to temperature rise denoting a temperature rise on the unexposed surface in excess of 650´F at the end of 30 minutes.

(c) ***Glass Lights.*** *All doors with glass vision panels of 100 square inches or less in area carry the same temperature rating as the door without glass lights. All doors with glass lights in excess of 100 square inches are rated as having a surface temperature in excess of 650´F max., at the end of 30 minutes.*

TABLE 12-7-4A-HOSE STREAM TEST

Desired Rating	***WATER PRESSURE AT BASE OF NOZZLE, POUNDS PER SQUARE INCH***	***DURATION OF APPLICATION, SECONDS PER SQUARE FOOT EXPOSED AREA***
3 hours	*45*	*3*
11/2 hours and over if less than 3 hours	*30*	*1.5*
1 hour and over if less than 11/2 hours	*30*	*0.9*
1 hour and over if less than 11/2 hours	*30*	*0.6*

Chapter 12-8-1
FIRE-RESISTIVE STANDARDS FOR FIRE PROTECTION
STANDARD 12-8-100
ROOM FIRE TEST FOR WALL AND CEILING MATERIALS
(See Chapter 35, California Building Code.)

STATE FIRE MARSHAL

Authority: *Sections 13143, 13146.1, Health and Safety Code* ***Reference:*** *Sections 13108, 13143, 13146.1, Health and Safety Code*

Scope Sec. 12-8-101.

(a) ***Basic.*** *This standard is intended to evaluate, under a specified fire exposure condition, the contribution to room fire growth provided by wall ceiling and/or floor materials or assemblies. This standard is not intended to evaluate the fire endurance or flamespread of material or assemblies.*

NOTE: *See State Fire Marshal (SFM) 7-1 and Uniform Building Code (UBC) Standard 8-1.*
This standard can be used to evaluate the effectiveness of thermal barriers in restricting the contribution of combustible materials in the wall and floor assemblies to fire growth in a padded safety cell. This standard shall be used in conjunction with ASTM E 603-77, "Standard Guide for Room Fire Experiments," which covers instrumentation, safety precautions, and the general effect of various parameters.

(b) ***Tests and Listings by Approved Testing Agency.*** *Test data for wall and/or ceiling materials or assemblies investigated and tested in accordance with the Standard for Safety established by Underwriters Laboratories, Inc., U.L. 723C, "Investigation for the Classification of Wall and Ceiling Interior Finish Materials and Assemblies Using a Room Fire Test," will be acceptable for evaluation against this standard, provided all instrumentation data required by this standard is incorporated in the test and report.*

(c) ***Test Simulation.*** *The test simulates a fire in the comer of an 8 foot by 12 foot compartment containing a single open doorway; this can be used to evaluate the relative performance of specific wall, ceiling and floor materials or assemblies when they are used together in the same relationship within an enclosure, in addition to simulating the manner in which they will be used.*

(d) ***Materials Considered.*** *The test may be used for evaluating wall, ceiling and flooring finish materials and assemblies, including panels, tiles, boards, sprayed or brushed coatings, etc.*

Fire and Smoke Measurements and Photographic Record Sec. 12-8-102.

(a) ***Significance.*** *This fire test is applicable to a description of certain fire performance characteristics in appraising wall, ceiling and flooring materials, products, or systems under specified fire exposure conditions in an enclosure. The test indicates the maximum extent of fire growth in an enclosure, the rate of heat release, and if they occur, the time to flashover and the time to flame extension beyond the doorway following flashover. Time to flashover is either the time when the radiant flux onto the floor reaches 20 kW/ m2 or the average temperature of the upper air reaches 1100? F. A crumpled up single sheet of newspaper may be placed on the floor 3 feet out from the center of the front wall.*

The spontaneous ignition of this newspaper will provide a visual indication of flashover. It determines both the extent to which the wall and ceiling materials or assemblies may contribute to fire growth in a compartment and the potential for fire spread beyond the compartment under the particular conditions simulated. It does not measure the contribution of the furnishing materials.

(b) ***Fire Measurements.*** *The potential for the spread of fire to other objects in the enclosure interior, remote from the ignition source, is evaluated by measurements of:*

1. The total heat flux incident at the center of the floor.

2. A characteristic upper level gas temperature in the test compartment.

(c) ***Fire Spread Potential.*** *The potential for the spread of fire to objects outside the compartment of origin is evaluated by the measurement of the total rate of heat release of the fire.*

(d) ***Smoke Measurements.*** *Measurements of the rate of production of carbon monoxide and visible smoke are taken.*

(e) ***Photographic Record.*** *The overall performance of the test specimen is to be visually documented by full color photographic records. Videotaping of the complete fire test may be done as an alternate to the continuous photographic record. Such records may show when each area of the test specimen becomes involved in the fire.*

(f) ***Photographic Specification.*** *Photographic equipment shall be used to continuously record the fire spread in the room and the fire projection from the door of the room. The location of the camera must avoid interference with the air inflow.*

NOTE: *A window, cut 2-0 above the floor wall facing the gas burner, fitted with heat-resistant, impact-resistant glazing provides useful photographic access. Flood lights should not raise the ambient temperature in the room above that specified in Section 12-8-110. The interior wall surfaces of the test room, adjacent to the corner in which the burner is located, shall be clearly marked with a 12-inch grid. A*

clock shall appear in all photographic records, giving the time to the nearest second (or 0.01 minute) from the start of the test. This clock shall be accurately synchronized with all other measurements, or other provisions shall be made to correlate the photographic record with time. Color slides shall also be taken at 15-second intervals for the first three minutes of the test and at a minimum of 30-second intervals thereafter for the duration of the test.

Report Sec. 12-8-103. *The report shall include the following items:*

1. ***Material description.*** *The name, thickness, density and size of the material shall be listed, along with other identifying characteristics or labels.*

2. Materials mounting and conditioning.

3. Layout of specimens and attachments in test room.

4. Relative humidity and temperature of the room and the test building prior to and during the test.

5. The fuel gas flow to the ignition burner and its calculated rate of gross heat output.

6. The total incident heat flux at the center of the floor shall be reported for each heat flux gage as a function of time starting one minute prior to the test.

7. The temperature of gases in the room, the doorway, and in the exhaust duct shall be reported for each thermocouple as a function of time starting one minute prior to the test. The temperature recorded by the thermocouple in the duct will be used in the required calculation.

8. The volumetric flow rate of the gas in the duct shall be calculated from Equation 12 in Appendix 12-8-1A and reported as a function of time starting one minute prior to the test.

9. The oxygen concentration in the analyzer shall be reported as a function of time starting one minute prior to the test.

10. The carbon dioxide concentration, if measured in the analyzer, shall be reported as a function of time starting one minute prior to the test.

NOTE: *Separate reporting of the volumetric flow rate, temperature, oxygen and carbon dioxide and/or carbon monoxide concentrations provide diagnostic information on the performance of the exhaust gas collection system and provide a check on the heat production calculations.*

11. The total rate of heat production shall be calculated from the measured oxygen and carbon dioxide and/or carbon monoxide concentrations, and the temperature and volumetric flow rate of the gas in the duct.

12. The product of the volumetric flow rate of the gas in the duct and the carbon monoxide concentration at the specified location in the combustion hood system shall be reported as a function of time after the start of the test.

13. The product of the volumetric flow rate of the gas in the duct at the duct gas temperature and the optical density per foot at the specified smoke meter location in the duct shall be reported as a function of time after the start of the test.

NOTE: *If this product is multiplied by 1.55 ?10-3, for English units, it gives the smoke units produced per second, where a smoke unit is defined as the quantity of smoke which, when distributed uniformly over a cubic meter, would have an optical density of unity over a path length of 1 meter. (This is the definition used in the Proposed ASTM Test for Heat and Visible Smoke Release Rates for Materials and Products.)*

14. A transcription of the visual, photographic, audio, and written records of the fire test shall be provided. The records shall indicate the time of ignition of the wall and ceiling finishes, the approximate location of the flame front most distant from the ignition source, at intervals not exceeding 15 seconds during the fire test, the time of flashover, and the time at which flames extend outside the doorway. In addition, still photographs taken at intervals not exceeding 15 seconds for the first three minutes, beginning at the start of the test and at every 30 seconds for the remainder of the test shall be supplied. Photographs showing the extent of the damage of the materials after the test shall also be supplied. The camera settings, film speed, and lighting used shall be described.

15. A report on the pretest calibration conducted in Section 12-8-113.

16. Report on the barometric pressure at time of test.

17. A complete discussion of the criteria. This shall include all calculations and references to other data used to satisfy the criteria presented in Section 12-8-115.

Test Samples Sec. 12-8-104. *Samples of the test material, both in its original (untested) and post-tested conditions, shall be retained by the testing agency. All samples shall be retained by the testing agency for a minimum period of three years from the date of the test. All samples shall measure 4 inches by 4 inches by the sample thickness. Two samples of the material in its original pretest condition shall be retained. These samples shall be taken from the same material lot used for the test samples. Post-test samples from the test shall include one each, from the geometric center of each wall panel and the ceiling panel, and one each from the following locations:*

1. The top, mid-height and bottom of each wall along the vertical centerline of each wall panel.

2. The quarter points of the ceiling, in those cases in which the test material was applied to the ceiling.
All samples shall be clearly identified as to the material, test date and their location within the room.

Summary of Method and Heat Source Sec. 12-8-105.

*(a) **Summary of Method.** The test involves an ignition source exposure of the wall, ceiling and/or floor lining materials or assemblies as they would be incorporated in actual safety cell installation.*

*(b) **Heat Source.** This method uses a gas burner to produce a diffusion flame in contact with the walls and ceiling in the corner of an 8 foot by 12 foot by 8 foot high compartment. The burner produces a prescribed gross rate of heat output as given in Table 12-8-1A and Figure 12-8-1.*
The contribution of the wall, ceiling and flooring materials or assemblies to fire growth is measured in terms of the time history of the incident heat flux at the center of the floor, the time history of the temperature of the gases in the upper part of the compartment, the time to flashover and the rate of heat release. The test is conducted with natural ventilation to the test compartment provided through a single doorway 30 inches by 80 inches in width and height. The combustion products are collected in a hood feeding into a plenum connected to an exhaust duct in which measurements are made of the gas velocity, temperature and concentrations.

Ignition Source and Location Sec. 12-8-106.

*(a) **Ignition Source.** The ignition source for the test shall be a gas burner with a nominal 12 inches by 12 inches porous top surface of a refractory material.*
***NOTE:** A burner may be constructed with a 1-inch porous ceramic- fiber board over a 6-inch plenum; or alternatively a minimum 4-inch layer of Ottowa sand can be used to provide the horizontal surface through which the gas is supplied. The sand burner may be preferable for dripping materials. This type of burner is shown in Figure 12-8-7.*

*(b) **Burner Location.** The top surface of the burner through which the gas is supplied shall be located horizontally, 12 inches off the floor, and the burner enclosure shall be in contact with both walls in a corner of the room opposite from the door. The edge of the diffusion surface shall be within 1 inch of the wall.*

*(c) **Gas Supply.** The gas supply to the burner shall be propane and shall produce a heat source as outlined in Section 12-8-105 (b). The flow rate shall be metered throughout the test. The burner shall be so designed that it can be set at the flow rates required to produce the gross rates of heat release as specified in Section 12-8-105 (b).*

*(d) **Ignition.** The burner may be ignited by a pilot burner or a remote controlled spark igniter.*

Compartment Dimensions and Construction Sec. 12-8-107.

*(a) **Compartment Geometry and Construction.** The interior dimensions of the floor of the fire room when the specimens are in place, shall measure 8 feet ?1 inch 12 feet ?1 inch. The finished ceiling shall be 8 feet ?0.5 inch above the floor. There shall be four walls at right angles defining the compartment.*

***NOTE:** The experimental choices for the sizes of compartment fire are discussed in Section 5 of ASTM E 603. The compartment size defined in this section has been chosen to makexperiments e it convenient to utilize standard size, 4 feet by 8 feet building materials or panels.*

*(b) **Doorway.** There shall be a 30-inch ?0.25-inch 80-inch ?0.25-inch doorway in the center of one of the 8 feet by 8 feet walls, and no other wall or ceiling openings that will allow ventilation.*

*(c) **Wall Construction.** The wall containing the door shall be of calcium silicate board of 46 pcf density and 0.5 inch nominal thickness. As an alternative to the calcium silicate board, 0.5 inch thick gypsum wallboard may be used. The door frame shall be constructed to remain unchanged during the test period to a tolerance of ?1 percent in height and width.*

*(d) **Compartment Construction.** The test compartment may be a framed structure or a concrete block structure. If self-supporting panels are tested, a separate exterior frame or block compartment may not be required.*

*(e) **Floor Materials.** The floor of the test compartment shall be noncombustible as defined by ASTM E 136.*

Specimen Mounting and Test Material Size Sec. 12-8-108.

*(a) **Specimen Mounting.** The specimens (e.g., the ceiling and wall materials whose condition is being tested) shall be mounted on a framing or support system comparable to that intended for their field use, using backing materials, insulation, or air gaps, as appropriate to the intended application and representing a typical value of thermal resistance for the wall system.*

*(b) **Test Material Size.** In the test, the ceiling material shall cover the entire ceiling if such an end use application is anticipated and the wall material shall cover three of the side walls, but not the wall containing the door. The wall and ceiling materials shall be mounted in the*

same wall-ceiling relationship in which they are intended for use, and it therefore may be necessary to actually construct a section of a prototype padded safety cell.

Fire Compartment Environment Sec. 12-8-109. *The test building in which the fire compartment is located shall have vents for the discharge of combustion products and have provisions for fresh air intake, so that no oxygen deficient air shall be introduced into the fire compartment during the test. Prior to initiation of the test the ambient air at the mid-height entrance to the compartment shall have a velocity in any direction of less than 100 feet per minute. The building shall be of adequate size so that there shall be no smoke accumulation in the building below the level of the top of the fire compartment.*

Ambient Conditions in Test Building and Fire Compartment Sec. 12-8-110.

(a) ***Ambient Conditions in Test Building.*** *The ambient temperature in the test building at any location outside the fire compartment shall be above 40? F; and the relative humidity shall be less than 75 percent for the duration of the test.*

(b) ***Ambient Conditions in Fire Compartment.*** *The ambient temperature in the fire compartment measured by one of the thermocouples specified in Section 12-8-112, Item 2., D., shall be within the range of 65? F to 75? F for at least 16 hours prior to the test.*

(c) ***Humidity.*** *The ambient relative humidity in the fire compartment for 16 hours prior to the test shall be within the range of 50 ?5 percent. This may require the use of a humidifier or dehumidifier.*

Specimen Conditioning Sec. 12-8-111. *The specimens shall be conditioned prior to mounting at a temperature of 70? F ?5? F, and at a relative humidity of 50 ?5 percent until they reach a rate of weight change of less than 0.1 percent per day.*

Instrumentation Sec. 12-8-112. *The following are the minimum requirements for instrumentation for this test:*

NOTE: *Added instrumentation may be desirable for further information.*

1. ***Total heat flux gages.***

A. ***Location.*** *Two gages shall be mounted within 5 inches of each other and within a distance of 2 inches above the floor surface upward in the geometric center of the floor.*

NOTE: *See Figure 12-8-2.*
One additional gage shall be mounted in the wall adjacent to the ignition burner during calibration tests only.

NOTE: *See Section 12-8-113, Item 2.*

It shall be 6 feet above the floor, and 6 inches from the corner where the burner is located, along the wall opposite the doorway.

The front surface of the calibration gage shall be flush with the wall surface, within 0.04 inch.

B. ***Specification.*** *The gages shall be of the Gardon type, with a flat black surface and a 180? view angle, and shall be maintained at a constant temperature, within + 1.8? F above the dew point by*
water supplied at a temperature of 120? F to 150? F. This will normally require a flow rate of at least 0.1 gpm. The full-scale output range shall be 5 Btu/ft.2/sec. for the floor gage and 10 Btu/ft.2/sec.
for the wall gage.

NOTE: *A suitable Gardon-type heat flux gage, manufactured by the Medtherm Corporation in Huntsville, Alabama, is listed under model 64-5-18 for the 5 Btu/ft.2/sec. range and under model 64-10-18 for the 10 Btu/ft. 2/sec. range. See R. Gardon, "An Instrument for the Direct Measurement of Intense Thermal Radiation," Review of Scientific Instruments, Vol. 24, No. 5, May 1953, pp. 36-70, for further information.*

2. ***Gas temperature thermocouples.***

A. ***Specification.*** *Twenty mil diameter bare chromel-alumel thermocouple wire within 0.5 inch of the bead should be run along expected isotherms to minimize conduction errors. The insulation between the chromel and alumel wires must be stable to at least 2000? F or the wires must be separated.*

NOTE: *Metal clad ceramic powder will work satisfactorily. The commonly used silicone-impregnated glass insulation will break down above 1500? F*

B. ***Location for doorway.*** *A thermocouple shall be located in the interior plane of the door opening on the door centerline, 1 inch down from the top.*

NOTE: *See Figure 12-8-3.*

C. ***Locations for room.*** *Thermocouples shall be located 4 inches down from the center of the ceiling and from the center of each of the four ceiling quadrants, and one shall be directly over the center of the ignition burner, 4 inches below the ceiling. The thermocouples shall be mounted on supports, with their junctions at least 4 inches away from a solid surface. There shall be no attachments to the test specimens.*

NOTE: *See Figure 12-8-3.*

D. ***Location in canopy hood and duct systems.*** *One pair of thermocouples shall be placed 11 feet downstream to the entrance to the horizontal duct. The pair of thermocouples shall straddle the center of the duct and be separated by 2 inches from each other.*

NOTE: *See Figure 12-8-4.*

3. ***Canopy hood and exhaust duct location and design.*** *A hood shall be installed immediately adjacent to the door of the fire room. The bottom of the hood shall be level with the top surface of the room. The face dimensions of the hood shall be minimum 8 feet by 8 feet and the depth shall be 3.5 feet. The hood shall feed into a plenum having a 3 foot by 3 foot cross section.*

NOTE: *See Figure 12-8-4.*
The plenum shall have a minimum height of 3 feet. The height can be increased up to a maximum of 6 feet to satisfy building constraints.
The exhaust duct connected to the plenum shall be 16 inches in diameter, horizontal, and shall have a circular aperture of 12 inches at its entrance.
The hood shall have sufficient draft to collect all the combustion products leaving the room. This draft should be capable of moving up to 5,000 standard cubic feet per minute (scfm) during the test.
Provisions shall be made to vary the draft so that it can operate at either 1,000 or 5,000 scfm. Mixing vanes may also be required in the duct if concentration gradients are found to exist.
An alternate exhaust system design may be used if it has been shown to produce equivalent results. Equivalency may be shown by meeting the requirements of Section 12-8-113, Item 5.

4. ***Duct gas velocity specification.*** *A bidirectional probe or equivalent measuring system shall be used to measure gas velocity in the duct.*

NOTE: *See B. J. McCaffrey and G. Heskjestad, Combustion and Flame, 26, 125-127 (1976).*
The probe shown in Figure 12-8-6 consists of a short stainless steel cylinder 1.75-inch long and 0.975-inch inside diameter with a solid diaphragm in the center. The pressure taps on either side of the diaphragm support the probe. The axis of the probe shall be along the centerline of the duct 11 feet downstream from the entrance. The taps shall be connected to a pressure transducer which shall be able to resolve pressure differences of 0.0001-inch of water.

NOTE: *Capacitance-type transducers have been found to be the most stable for this application.*

NOTE: *The bidirectional probe is specified rather than the pilot- static tube in order to avoid problems of clogging with soot.*

5. ***Duct oxygen concentration specification.*** *A stainless steel gas sampling tube shall be located 13 feet downstream from the entrance to the duct, to obtain a continuously flowing sample for determining the oxygen concentration of the exhaust gas as a function of time. A suitable filter and cold trap shall be placed in the line to remove particulates and water. The oxygen analyzer shall be of the paramagnetic or polarographic type and shall be capable of measuring the reduction in oxygen concentration over the range of 0.21 down to 0.15 with an accuracy of ? 2 percent in this concentration range. The signal from the oxygen analyzer must be within 5 percent of its final value in 30 seconds after introducing a step change in composition of the gas stream flowing past the inlet to the sampling tube.*

6. ***Duct carbon dioxide concentration specification.*** *The gas sampling tube defined in Section 12-8-112, Item 5, or an alternate tube in the same location, shall provide a continuous sample for the measurement of the carbon dioxide concentration with an analyzer which has a range of 0 to 20 percent and a maximum error of 2 percent of full-scale. The total system response time between the sampling inlet and the meter shall be no greater than 30 seconds.*

7. ***Duct carbon monoxide concentration specification.*** *The gas sampling tube defined in Section 12-8-112, Item 5, or an alternate tube in the same location, shall provide a continuous sample for the measurement of the carbon monoxide concentration with an analyzer which has a range of 0 to 10 percent and a maximum error of 2 percent of full-scale.*

8. ***Optical density of smoke in duct specification (supplementary measurement).*** *A meter shall be installed to measure the optical density of the exhaust gases in a vertical path across the width of a horizontal duct, 1 foot downstream of the duct velocity probe. A horizontal path should be used with a vertical duct.*

A suitable design for the meter is as follows: Use as a light source a number 1810 lamp which is rated at 6.3 volts, 0.40 amps, and 1.5 candela and is operated at 5 volts d.c. The lamp is mounted at the focal point of a + 20 diopter and 50 mm diameter double convex collimating lens. At the other side of the duct the collimated beam is intercepted by a + 10 diopter 50 mm diameter plane convex lens and concentrated onto the cathode of a 1P39 phototube. A Corning CS3-132 type 3304 filter (available from the Swift Glass Company, Box 890, Elmira Heights, NY 14903) is used in front of the phototube to correct its spectral response to the standard photoptic curve of the human eye.

The lens, filter and phototube are mounted inside of a light-tight housing which is blackened inside to minimize internal reflections. The phototube is connected to a linear operational power amplifier with an adjustable gain of 106 which in turn is connected to a commercially available log ratio amplifier to produce an output voltage proportional to the optical density. A smoke meter meeting the above requirements is described in a report by R. W.

Bukowski, "Smoke Measurements in Large- and Small-scale Fire Testing," NBSIR 78-1502, October 1978. Alternate systems can be used, but the color temperature of the light source must match that of the 1810 lamp under the specified operating conditions, and the light receiver, including the photo detector, must match the standard photoptic curve of the eye.

The optical density shall be continuously recorded over the duration of the test. After completion of the test, the optical den sity reading must be less than 0.02 (transmission higher than 95 percent).

Calibration and Documentation of Ignition Source and Test Equipment Sec. 12-8-113. *A calibration test shall be performed prior to and within 30 days of any fire test. The calibration test, to last for 15 minutes, shall use the standard ignition source with inert wall and ceiling materials (calcium silicate board of 46 pcf density and 0.5-inch thickness. The following quantities shall be reported:*

1. Once the burner is activated, the output of all instruments normally used in the test is to be measured and data recorded as a function of time.

2. The time history of the total heat flux at the wall location.

3. The maximum extension of the burner flame as recorded by still color photographs of 0.1 second exposure time taken at a minimum of 30-second intervals, or more often if it is changing rapidly. These shall be taken with a camera operating in the "operative mode" with the camera set to the standard ASA ratings of the film.

4. The temperature and velocity profiles across the duct cross- section at the location of the bidirectional probe if one is used. These profiles shall be used to determine the factor "k" in Equation 12, Appendix 12-8-1A.

5. The total rate of heat production is determined both by the oxygen consumption calculation and by the metered gas input. These must agree within 5 percent.

NOTE: *The net heat of combustion is 2,283 Btu/ft.3 for propane at 68? F and 14.7 psi. This value should be used in this calculation.*

Test Procedure Sec. 12-8-114. *The following paragraphs describe the steps in the test procedure:*

1. Establish an initial volumetric flow rate of 1,000 cfm through the duct if a forced ventilation system is used. If a forced ventilation system is used, increase the volume flow rate through the duct to 5,000 cfm when the oxygen content falls below 18 percent.

2. Turn on all sampling and recording devices and establish steady state baseline readings for at least one minute.

3. Ignite the gas burner and start the clock simultaneously. Increase gas flow rate in steps as indicated in Section 12-8-106 (c).

4. Take 35 mm color slides at 15-second intervals during the first three minutes and at 30-second intervals thereafter to photographically document the growth of the fire.

5. Provide a continuous voice or written record of the fire, which will give times of all significant events such as flame attachment to the wall, flames out of the doorway, flashover, etc.

6. The ignition burner shall be shut off at 15 minutes after initiation of the test and the test terminated at that time unless safety considerations dictate an earlier termination.

7. Photograph and verbally describe the damage after the test.

Flashover and Smoke Sec. 12-8-115.

(a) ***Flashover.*** *The criterion for acceptable performance shall be that the compartment never reaches flashover at any time during the 15-minute period of ignition source burner operation.*
Flashover shall be considered to have occurred if one or more of the following conditions occur during the test:

1. The average ceiling gas temperature, as determined by averaging the temperature at the center and quarter point thermocouples, reaches or exceeds 1112? F.

2. The total heat flux at the floor, as determined by either of the total heat flux meters mounted in the geometric center of the floor, reaches or exceeds a value of 1.761 Btu/ft.2/sec.

3. Visible flaming extends from the doorway of the test compartment.

(b) ***Smoke.*** *Materials meeting the acceptance criteria of this standard shall have a smoke density rating no greater than 75 when tested in the thickness intended for use by UBC Standard 26-5, or when tested in accordance with UBC Standard 8-1.*

Markings Sec. 12-8-116. *All materials shall be provided with a manufacturer's label or other permanent marking clearly identifying the manufacturer label or other permanent marking clearly identifying the manufacturer, the product and model numbers (or brand name). Materials approved and listed by the State Fire Marshal shall be marked as required by Section 1.58, Title 19, C.A.C.*

TABLE 12-8-1A-IGNITION SOURCE RATE OF HEAT RELEASE PROGRAM FOR TESTS OF SAFETY CELL PADDING MATERIALS

ELAPSED TEST TIME (Min)	*BURNER GROSS RATE OF HEAT RELEASE (KW)*
0	*44*
1	*88*
2	*132*
3	*132*
4	*88*
5-15	*44*

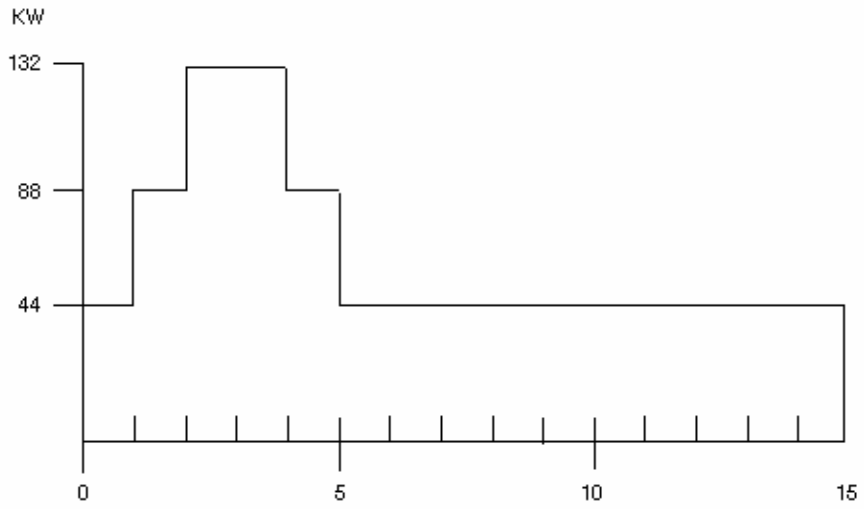
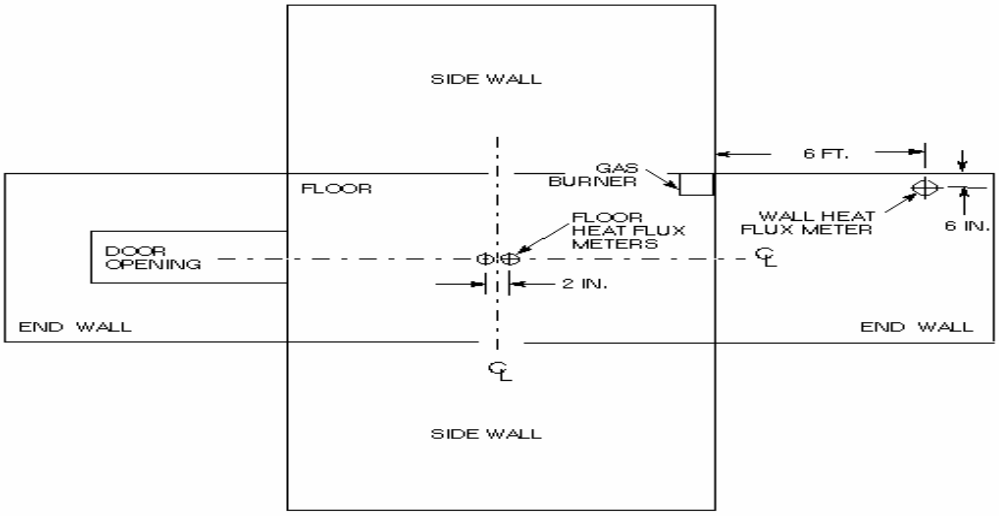


FIGURE 12-8-1-TIME-MINUTES

FIGURE 12-8-2-LOCATION OF HEAT FLUX METERS



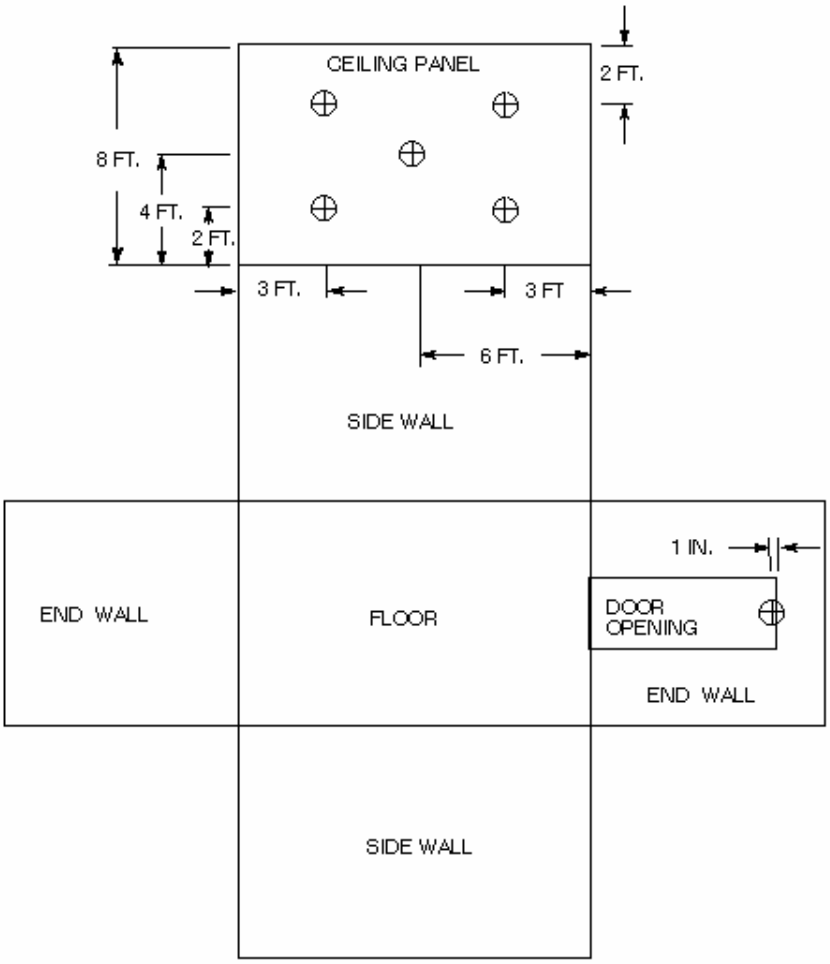
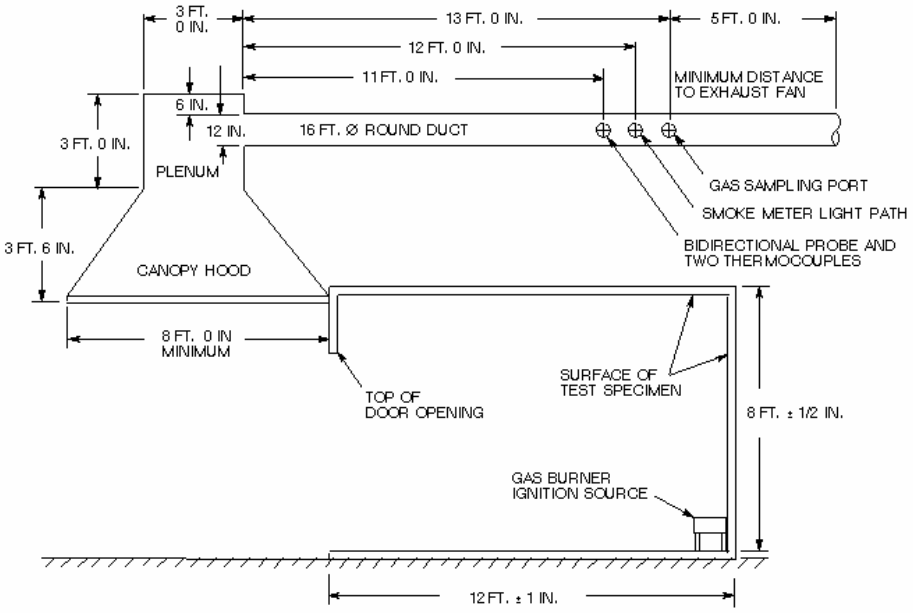


FIGURE 12-8-3-ROOM THERMOCOUPLE LOCATIONS NOTE: *Two 0.20 mil. Type K thermocouples at each location*



NOTES:

1. PLENUM HEIGHT MAY BE INCREASED UP TO 6 FT. TO ADJUST FOR BUILDING CONSTRAINTS.
2. SUPPORT FOR HOOD MUST NOT INTERFERE WITH AIR INFLOW TO ROOM.
3. THE EXHAUST SYSTEM MUST BE CAPABLE OF EXHAUSTING AT LEAST 5,000 SCFM. THIS MAY RESULT IN A FLOW OF UP TO 12,000 ACFM, DEPENDING ON DUCT GAS TEMPERATURE.

FIGURE 12-8-4-SECTION VIEW OF ROOM TEST APPARATUS

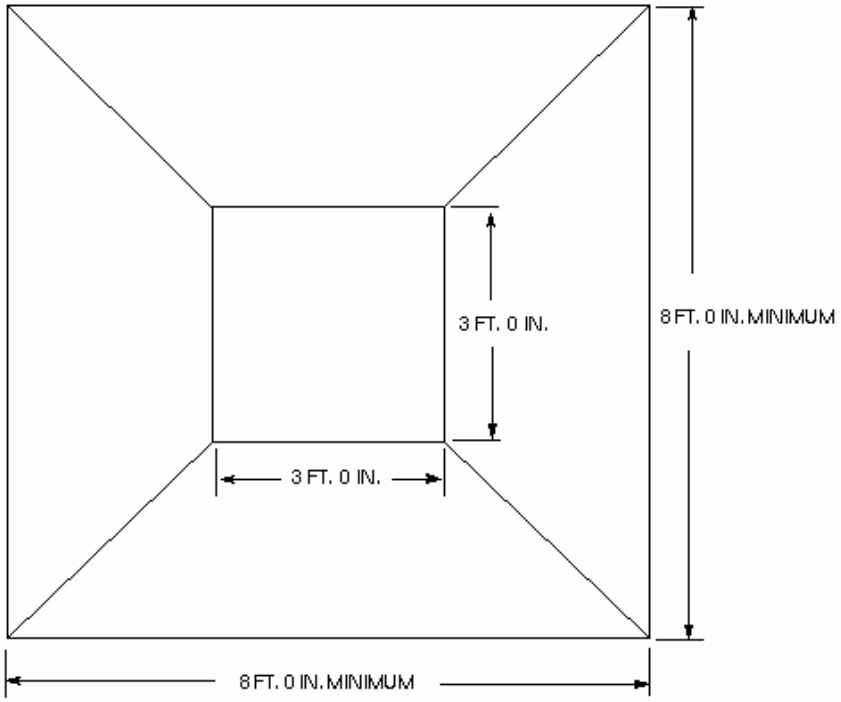


FIGURE 12-8-5-PLAN VIEW OF CANOPY HOOD

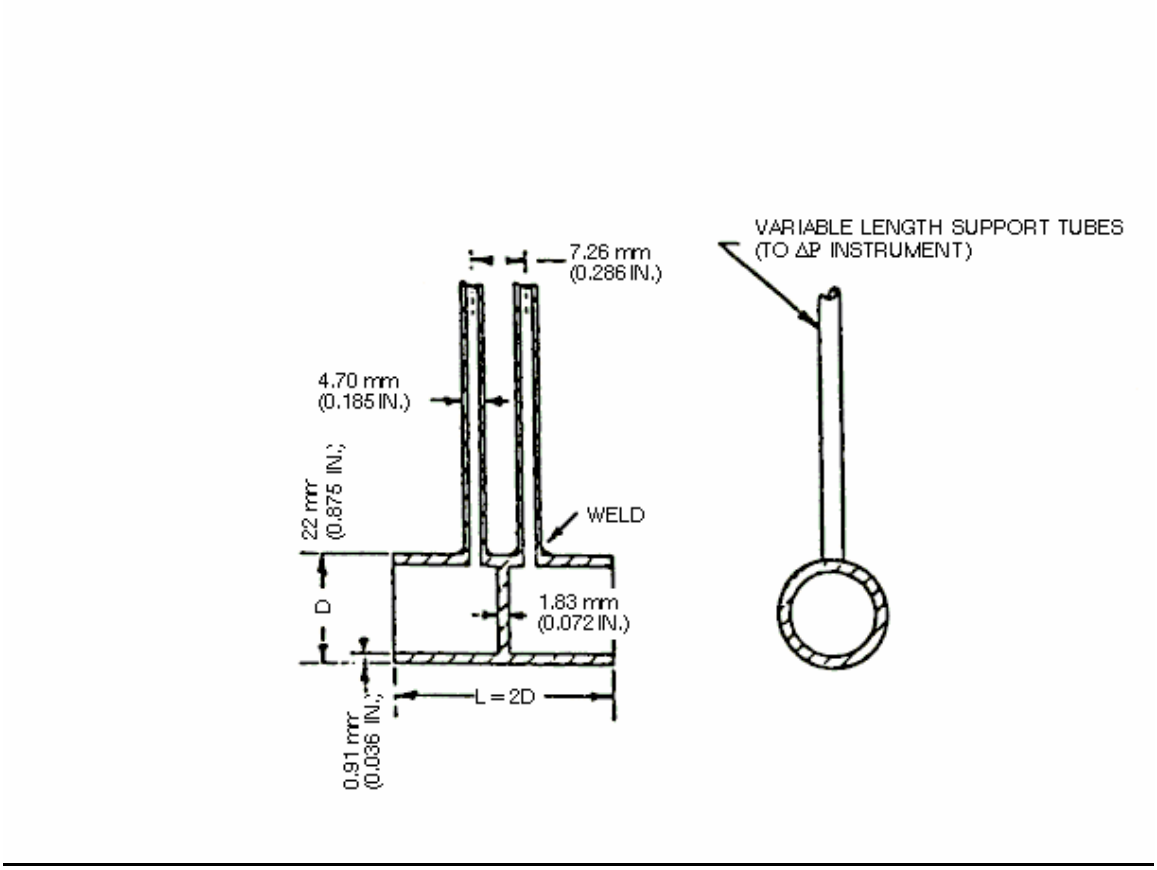


FIGURE 12-8-6-BIDIRECTIONAL PROBE

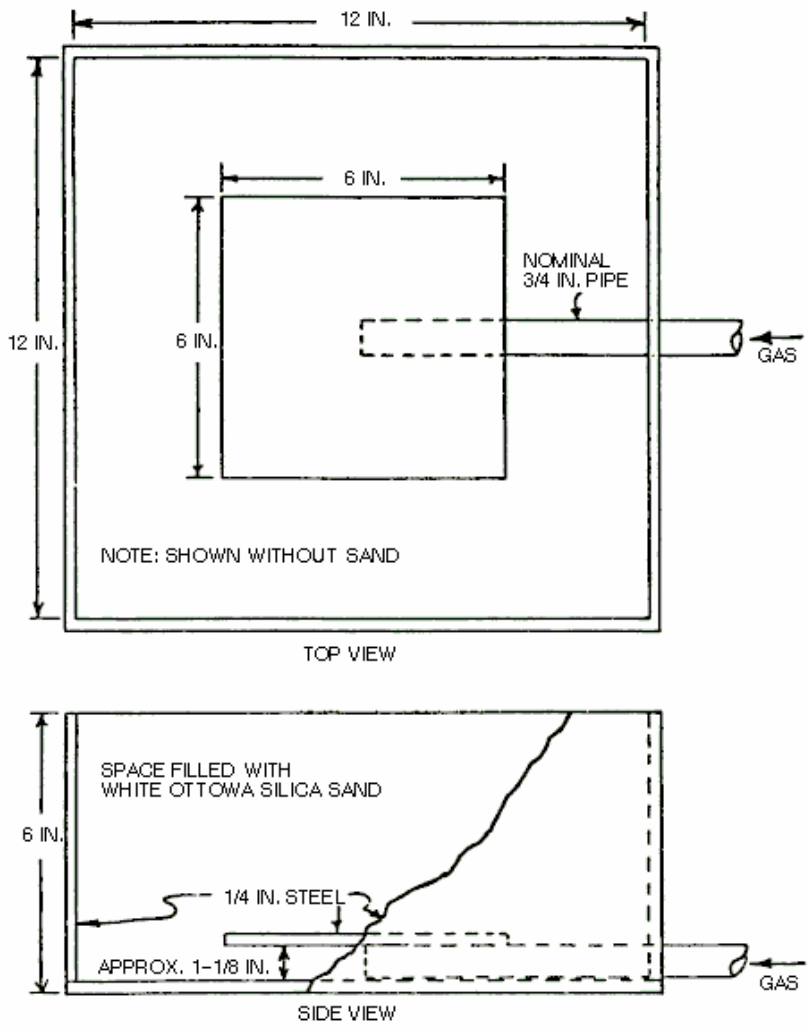
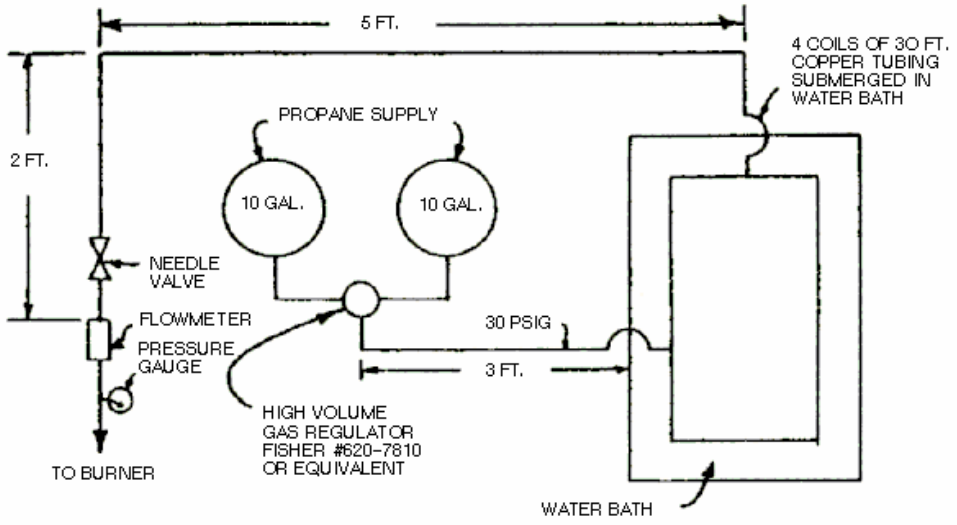


FIGURE 12-8-7-GAS BURNER

FIGURE 12-8-8-BURNER GAS FLOW CONTROL AND MEASUREMENT



Appendix 12-8-1A
CALCULATION OF THE TOTAL RATE OF HEAT AND CARBON MONOXIDE OR CARBON DIOXIDE PRODUCTION

The total rate of heat production is given by
Q = E ? X o O 2 V A (1)?

WHERE:
E = the heat release per volume of oxygen consumed, 467 Btu/ft.3 ? ? the fraction of the oxygen consumed
X o O 2 = the ambient molar concentration of oxygen VA = the volume flow rate of air into the system corrected to 36? F (including that which enters the room and that which passes directly into the exhaust duct).
The oxygen depletion is given by
? M o O 2 = M o O 2 - M O 2 (2)

WHERE:
M o O 2 = the molar flow rate of oxygen into the system
M O 2 = the molar flow rate of oxygen in the exhaust duct.
The concentrations of oxygen and carbon dioxide in the analyzers are given by
X O 2 = M o 2
M o N 2 = M O 2 = M C O 2 (3)
X C O 2 = M C O 2
M o N 2 = M O 2 = M C O 2 (4)

WHERE:
M o N 2 = the molar flow rate of nitrogen into the system
M C O 2 = the molar flow rate of carbon dioxide in the exhaust duct.
It is assumed that all the water is trapped out and that the only gases passing through the analyzers are nitrogen, oxygen and carbon dioxide.
Combining Equations 3 and 4 to get
M C O 2 = X C O 2 M O 2 X O 2
and noting that
? O 2 = M o o 2 M o N 2 = M o O 2
Equation 3 can be solved for Mo,
M O 2 ?
M o O 2 [(X O 2 X o O 2) - X O 2]
1 - X O 2 - X C O 2
(5)
which, when substituted into Equation 2, yields
? X o O 2 = ? X O 2 (1 - ? X C O 2)
X o O 2 [1 - ? X O 2 (1 - ? X C O 2)]
(6)
The volumetric flow rate in the exhaust duct is given by
(7)
V S (1 - ? ?) V A = ? ? V A

WHERE:
VS = referred to standard conditions 68? F.
VA = referred to standard conditions 68? F.
= the expansion factor, due to chemical reaction, of the air that is depleted of its oxygen.
X o N 2 = b X o O 2 0 . 7 9 0 . 2 1 b (8)
where b is the ratio of the moles of combustion products formed to the moles of oxygen consumed. The value of ranges from 1.000 for carbon to 1.175 for cellulose with the plastics having values in between. In order to reduce the error incurred when unknown products are burning is taken to have an intermediate value of 1.084 which is exact for propane, the burner gas.
From Equation 7, the volumetric flow rate of air entering the system is
V A = V S (1 - ?) ? (9)
Setting: = 1.084 E = 467 Btu/ft.3
X o O 2 = 0.21
Equation 1 becomes
Q = E ? X o O 2 V S
1 - ?) ?
9 8 . 1 ? V S 1 0 . 0 8 4 ?
Btu/min. (10)
?
if VS is in cfm referred to 68? F.
Setting E = 17.4 MJ/m3
Q = 3 . 6 5 ? V S 1 0 . 0 8 4 ?
MW (11)
?

WHERE:
VS = in m3/sec, and is determined from the flow measurement in the exhaust duct ?? the oxygen depletion, which is obtained from Equation 6.

When the velocity is measured with a bidirectional probe and the Reynolds number correction is taken into account, the volumetric flow rate in m3/sec. in the duct under standard conditions is given by
VS0.926kA [(2?0) (TOT)]12
20.1kA?T

(12)
WHERE: *0.926 = a suitable calibration factor for air velocities in excess of 3 ft./sec. in a 16-inch duct k = the ratio of the average duct gas mass flow per unit area, as determined by measuring the velocity and temperature profiles across the stack, and the velocity and temperature at the center line where the bidirectional probe is located during the test A = the cross-sectional area of the duct in m2 at the location of the probe ? the differential pressure measured with the probe in Pa o = the density of air in kg/m3 at the reference temperature TO in K T = the duct gas temperature in K.*

The volumetric flow rate can be expressed in standard cubic feet per minute (scfm) at 60? F using common engineering units by
VS8.38104kA[?(t459)]12
scfm (13)

WHERE:
A = given in ft2 and in. of water ? given in ft2 and in. of water t = the duct gas temperature in F.
The volume flow rate of CO in m3/sec. through the duct can be found from the formula
VCO0.79VSXCO
(10.0847) (1XO2XCO2XCO)
(14)

WHERE:
XCO = the concentration of carbon monoxide measured in the analyzer.
This can be derived as follows
VCOVA
MCOMAIR
MCOMO2
MO2MoO2
MoO2MA
XCOXO2
MO2MoO2
XoO2 (15)

WHERE: *MCO and MA = the molar flow rates of carbon dioxide in the duct and of the air into the system including that flowing into the room and that entering the exhaust duct directly.*
The ratio of the CO and O2 concentration in the duct are the same as in the analyzer so that
MCOMO2
XCOXO2
(16)
When CO is present in the sampling line, Equation 5 becomes
MO2MoO2
(XO2XoO2) - XO2
1 - XO2 - XCO2 - XCO
(17)
Equation 14 is obtained by combining equations 15, 16 and 17, letting
1 - XoO20.79, and letting
VAVS10.084?
When CO is not measured, but is removed from the sample line and CO is measured, ? and
Q?
are calculated as follows
?XoO2 - (XO21-XCO)
XoO2(XO21 - XCO)
(18)
Q ?[???((E???E)E)((1?)2)(XCOXO2)]) (19)
?
EXoO2VA(MW)

WHERE:
E? 23.4 MJ/m3 E? 17.4 MJ/m3 VA = m3/sec.
referred to a 68? F base. Thus,
Q?
becomes

$$Q \approx [0.345((1-\beta^2)/(X_{CO}-X_{O2})](20)$$

$$1-1.4X_{O2}A/(MW)$$

When Equations 18 through 20 are used to calculate the rate of heat release, Q, the carbon dioxide must be removed from the sample streams flowing through the oxygen and carbon monoxide analyzers. The removal of carbon dioxide can be accomplished by passing the sample stream through a filter of either ascarite or an aqueous solution of sodium hydroxide.

Appendix 12-8-1B
GUIDE TO MOUNTING TECHNIQUES FOR
WALL ANDCEILING INTERIOR FINISH MATERIAL

General Sec. 12-8-1B.1.

(a) ***Basic.*** *This guide is intended as an aid in determining the method of mounting various building materials in the standard fire test room. These mountings are described for test method uniformity and good laboratory practice; they are not meant to imply restriction in the specific details of field installation. They are intended to be used for general material testing where the specific details of the field installation either have not been established or are so broad that any single installation method may not be representative of the full range of installation possibilities.*

(b) ***Mounting Methods.*** *The suggested mounting methods are grouped according to building materials to be tested which are broadly described either by usage or by form of the material. For some building materials, none of the methods described may be applicable. In such cases, other means of attachment may have to be devised. Wherever possible, these specimens shall be mounted using the same method of attachment as that contemplated in the field installation.*

(c) All backing materials, when used, shall be supported on a framed support system. A typical supporting framework is shown in Figure 12-8-1B-1.

(d) Whenever calcium silicate board or gypsum wallboard is specified as a backing substrate in subsequent paragraphs, the material shall be 0.5-inch-thick calcium silicate board supplied in 4 feet by 8 feet sheets with a density of 46 lb./ft.3, or 0.625-inch- thick gypsum wallboard "Type X" supplied in 4 feet by 8 feet sheets with a density of 42.2 lb./ft.3 and they shall be uncoated.
Where metal screws in combination with washers and wing nuts are specified for fastening, they shall be standard 0.25-inch by 20 TPI round head steel machine screws, 0.25-inch by 20 TPI steel wing nuts and 2 inch O.D. by 0.044-inch-thick flat steel washers with a 0.281-inch I.D. hole. Fastening screws shall be installed as shown in Figure 12-8-1B-2. The fastening pattern is shown in Figure 12-8-1B-3 for rigid wall materials and Figure 12-8-1B-4 for flexible wall materials. The fastening pattern for all ceiling materials is shown in Figure 12-8-1B-5.

Acoustical Materials and Other Board Materials Sec. 12-8-1B.2.

(a) Depending on the type of field mounting required by the acoustical product, either wood furring strips or metal runners are to be used to support acoustical material.

(b) Wood furring strips for mounting acoustical materials and other board materials are to be nominal 1-inch by 2-inches wood furring strips and attached to a gypsum wall board substrate to approximately the field installation.

(c) Metal runners for mounting are to be attached to the 0.625-inch gypsum wallboard substrate to approximate the field suspension systems application.

Batt or Blanket-type Insulating and Other Flexible Materials Sec. 12-8-1B.3. *Batt or blanket and other flexible materials which do not have sufficient rigidity or strength to support themselves are to be supported by round head machine screws in combination with wing nuts and flat washers, as specified in Section 12-8-1B.1 (d), which are inserted through the material in such a way as to fasten the material to a substrate board.*

Building Units Sec. 12-8-1B.4. *Materials falling within this category include organic and/or inorganic materials formed or laminated into blocks, boards, planks, slabs, or sheets of various sizes, thicknesses, or shapes. If building units have sufficient structural integrity to support themselves, no additional mounting to a substrate board support is required. If the building units are of such construction as to require individual components and are not self-supporting, the component is to be fastened to the substrate board as specified in Section 12-8-1B.1 (d).*

Coatings or Spray Applied Materials Sec. 12-8-1B.5.

(a) Coating materials, such as cementitious mixtures, mastic coatings, sprayed fibers, etc., are to be mixed and applied to the substrate board as specified in the manufacturer's instructions at the thickness, coverage rate or density recommended by the manufacturer.

(b) Materials intended for application to a wood surface are to be applied to a substrate made of 1 inch by 4 inches nominal "C" and better VG Douglas fir flooring (FSC 70 to 90) or to other species for which the surface burning characteristic is to be measured.

(c) Coating materials intended for application to particular combustible surfaces, but not wood, are to be applied to the specific surface for which they are intended. The coating material and combustible material are to be attached to the substrate board as specified in Section 12-8-1B.1 (d).

(d) Coating materials intended only for field applications to nonflammable surfaces are to be applied to 0.5 in calcium silicate board.

Wall Covering Material Sec. 12-8-1B.6. *Wall coverings such as vinyl coatings, wallpaper, etc., of various types are to be mounted on 0.625-inch gypsum wallboard or on the actual substrate to which they are to be applied, using the adhesive and application technique specified by the manufacturer.*

FIGURE 12-8-1B-1-TYPICAL STEEL FRAME SUPPORT SYSTEM

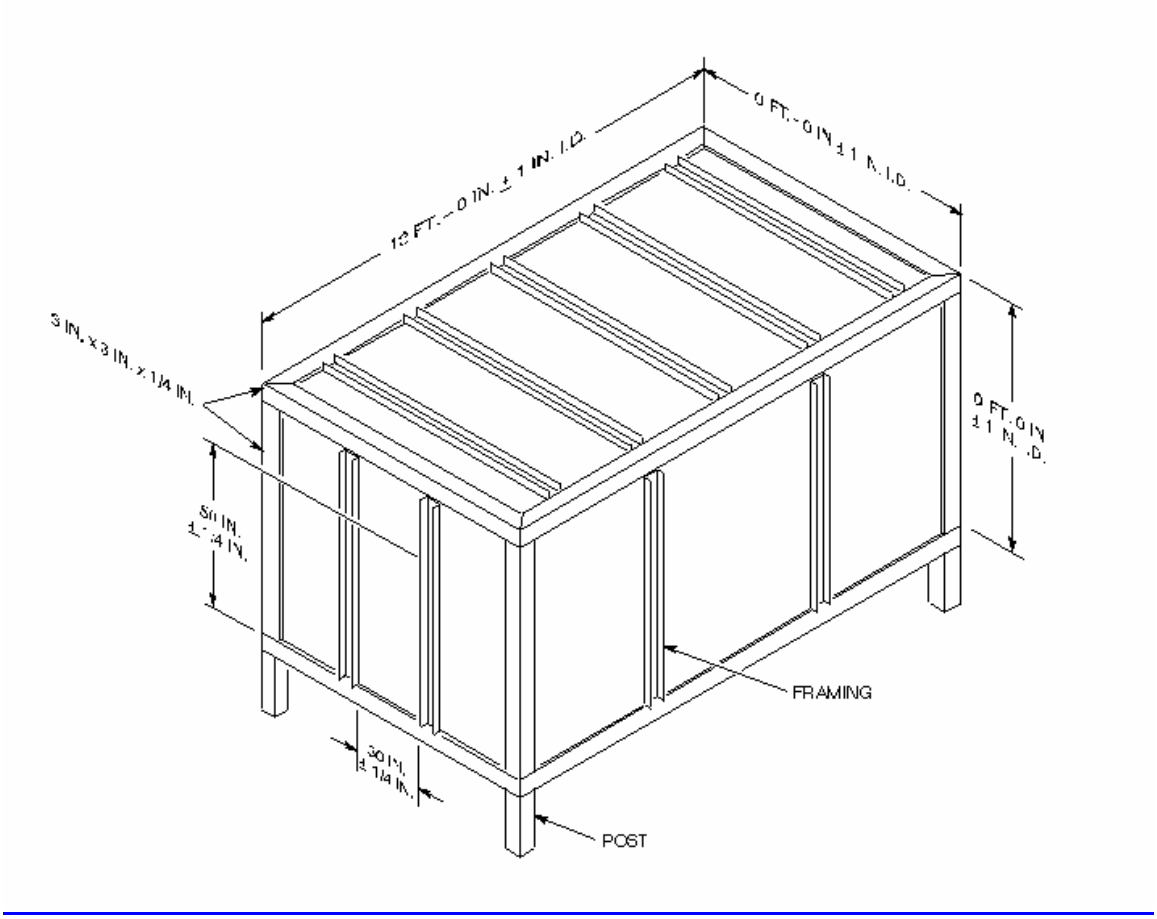


FIGURE 12-8-1B-2-MATERIAL FASTENING TECHNIQUE

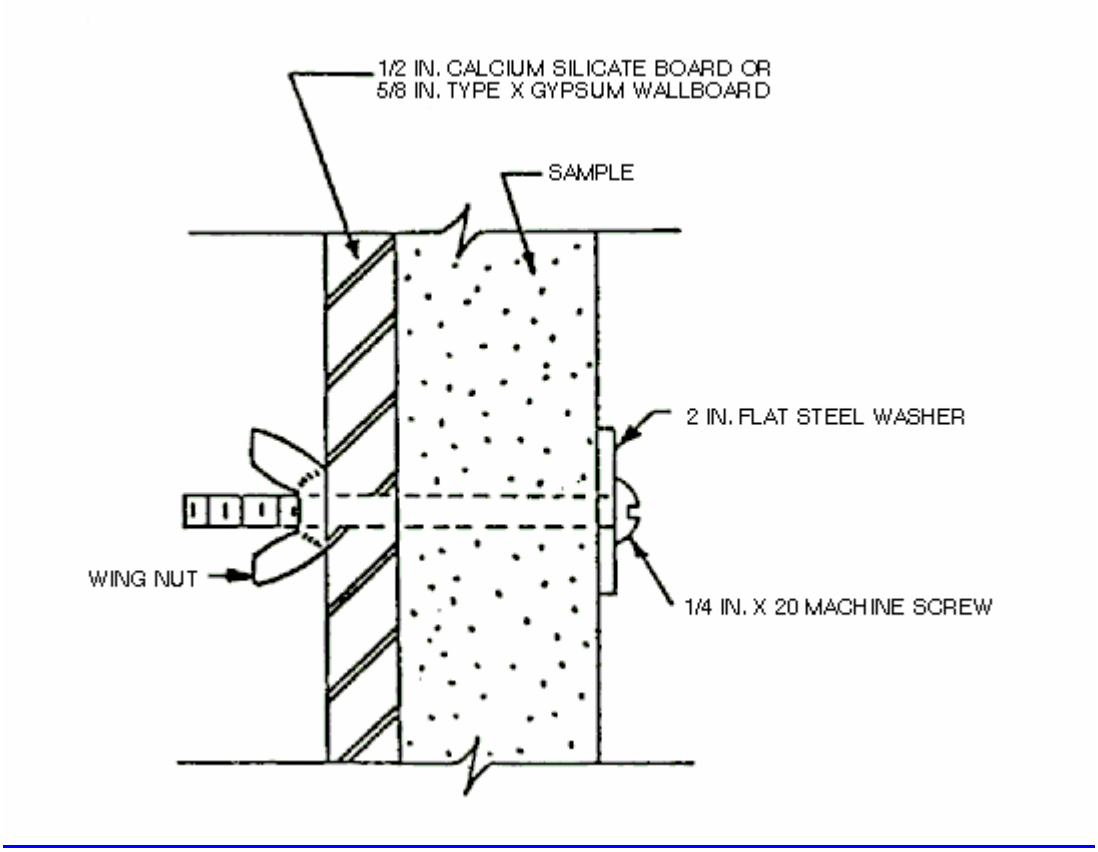
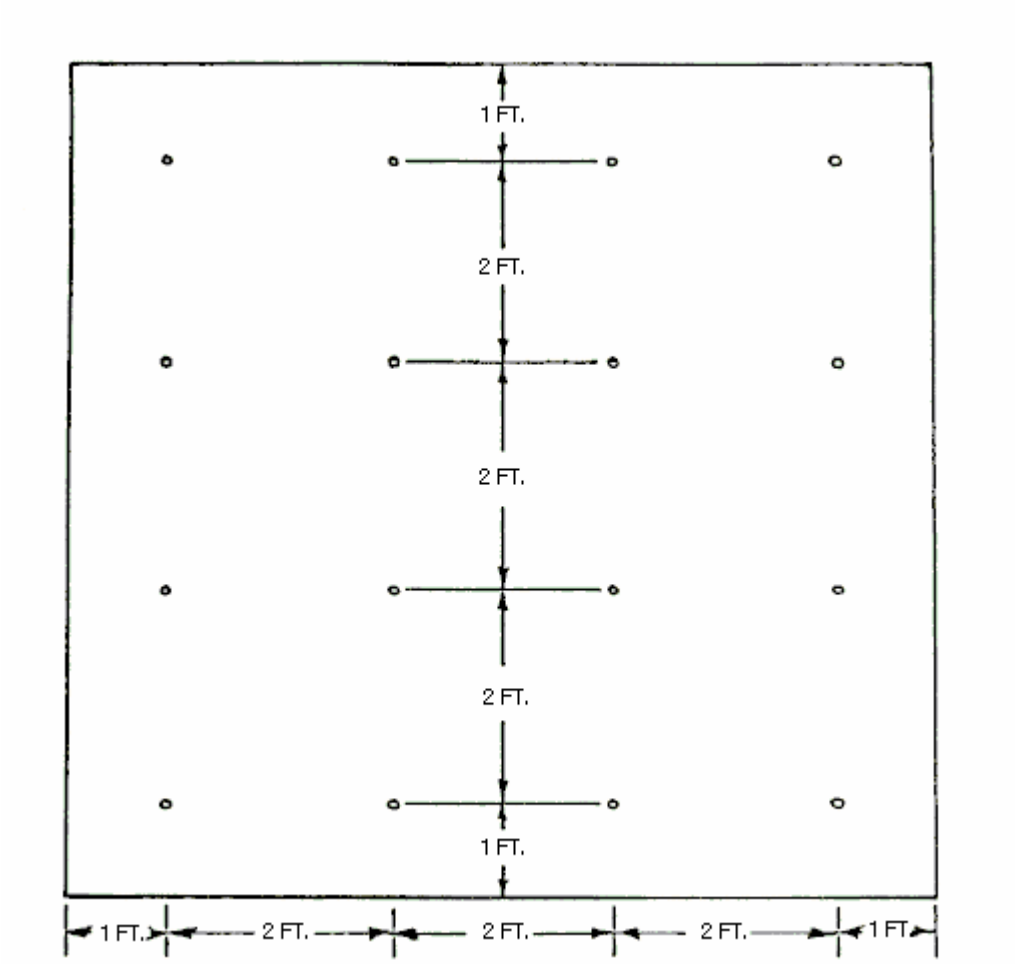


FIGURE 12-8-1B-3-TYPICAL MOUNTING TECHNIQUE FOR RIGID WALL MATERIALS



NOTE: *When required, additional fasteners may be used to hold up the specimen flush to the wall*

FIGURE 12-8-1B-4-TYPICAL MOUNTING TECHNIQUE FOR FLEXIBLE WALL MATERIALS

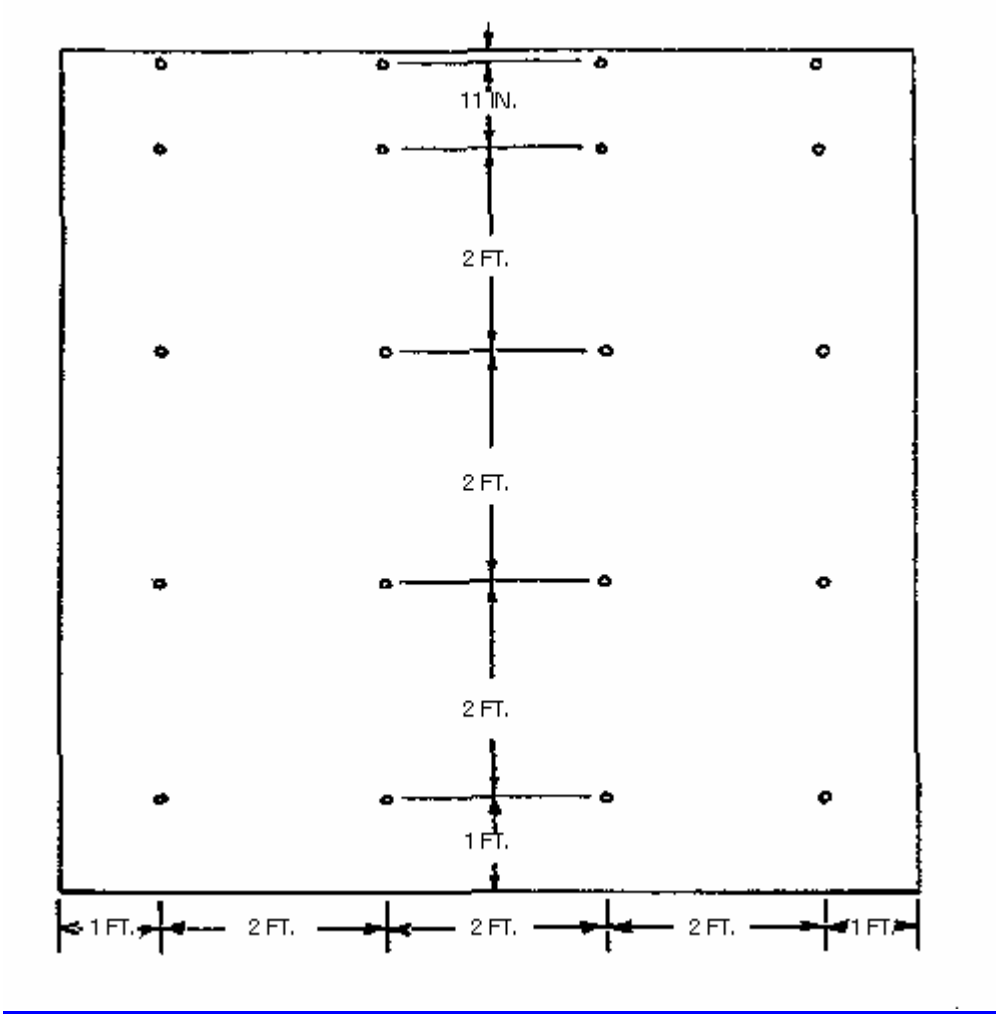
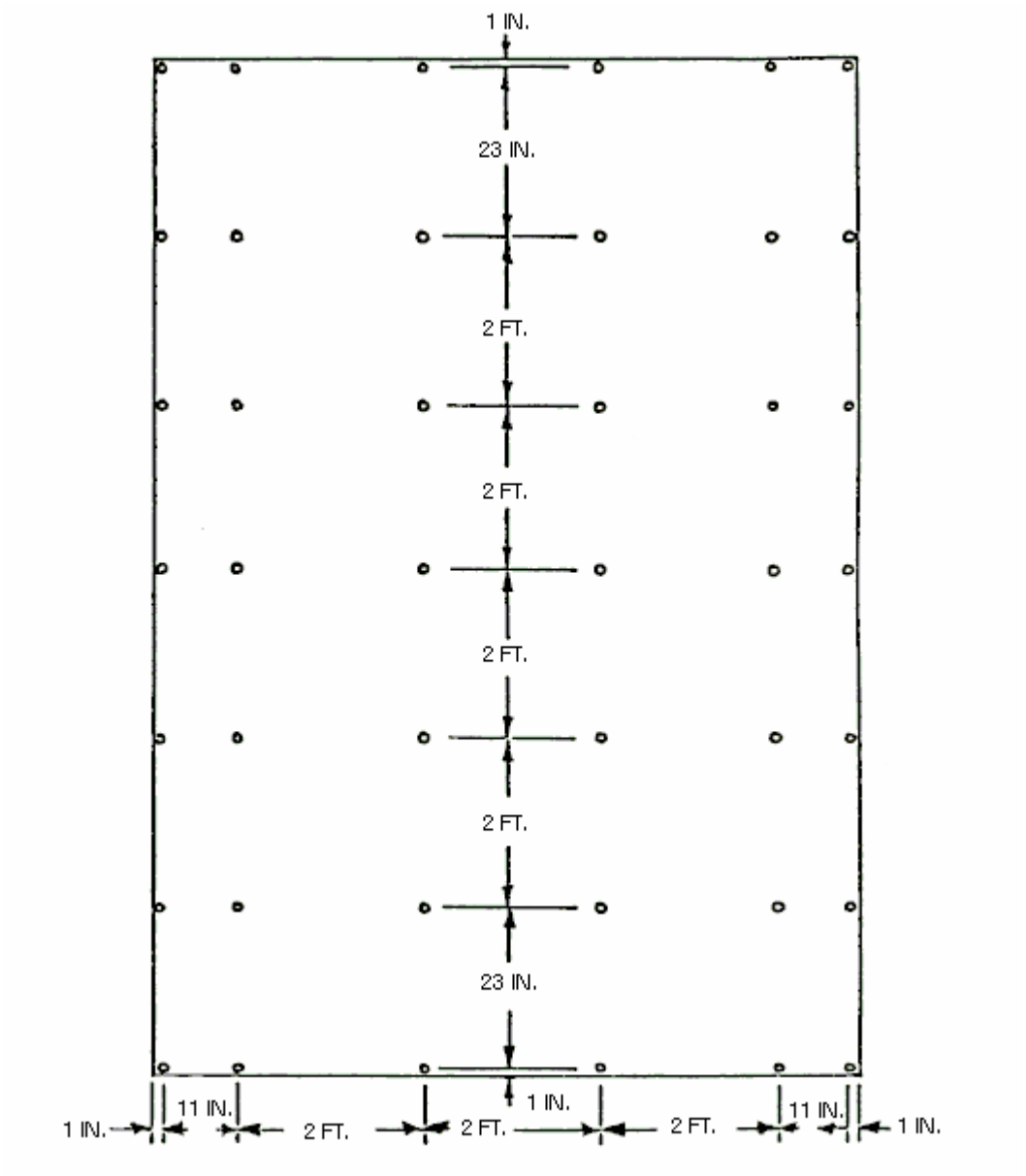


FIGURE 12-8-1B-5-TYPICAL MOUNTING TECHNIQUE FOR CEILING MATERIALS



Chapter 12-10-1
EXITS POWER-OPERATED EXIT DOORS
STANDARD 12-10-1

STATE FIRE MARSHAL

Scope Sec. 12-10-100.

(a) ***General.*** *These requirements and methods of test apply to power operated: swinging doors, and combination sliding and swinging doors intended for installation in locations where conforming exits are required by Title 24, California Code of Regulations, Part 2, Chapter 10.*

(b) Power-operated doors described in (a) may be provided with air, hydraulic or electric operators actuated from a floor, activating carpet, photoelectric device or other approved signaling device.

(c) ***Alternates.*** *A product employing materials or having forms of construction differing from those described in this procedure may be examined and tested in accordance with the intent of these testing procedures and, if found to be substantially equivalent, may be recognized for listing.*

(d) ***Application.*** *The minimum design, construction and testing procedures set forth herein are those deemed as the minimum necessary to establish conformance to the regulations of the State Fire Marshal contained in Title 24, California Code of Regulations.*

(e) ***Fire Door Assemblies.*** *Power-operated doors intended for installation in openings where listed fire door assemblies are required, shall in addition to the requirements of this standard, be tested in accordance with the Fire Door Assembly Tests, SFM 12-7-4.*

General Sec. 12-10-101.

(a) ***Panic Hardware.*** *Power-operated doors intended for installation in openings where panic hardware is required shall be tested with listed panic hardware on the doors.*

(b) ***Glazed Doors.*** *Glazing of doors shall conform to Title 24, California Code of Regulations, Part 2, Chapter 7.*

(c) ***Opening Degree.*** *Where manually operated in the direction of egress, leaves of swinging doors or swing-out sections of sliding doors shall swing open to not less than 90 degrees from the closed position.*

(d) ***Locking Mechanisms.*** *Locking mechanisms on doors intended for locations which do not require panic hardware shall be of a type readily identified as locked, and the doors shall be posted with durable, permanent signs reading "THESE DOORS TO REMAIN UNLOCKED WHENEVER THE PUBLIC IS PRESENT." Signs shall be 1-inch high block letters on a contrasting background. Signs shall be located on the header framing.*

(e) ***Swinging and Sliding Doors.*** *Each swing-out leaf of swinging or sliding doors with swinging sections shall be provided with durable signs in not less than 1-inch block letters on contrasting background wording, "IN EMERGENCY, PUSH TO OPEN," or other approved wording. The sign shall be located at the closing edge of the door not less than 36 inches or more than 60 inches above the floor. The sign shall read horizontally and be in two lines.*
Illuminated exit signs when required by other provisions of the basic building regulations shall be installed above the header. Wiring and circuit arrangement shall conform to the provisions of the California Electrical Code.

(f) ***Electrical Wiring and Devices.*** *Electrical wiring, electrical devices, and controls shall be of a type tested and listed in conformance with the standards established by the California Electrical Code, or shall be tested for conformance with the testing procedures approved by the State Fire Marshal.*

(g) ***Testing.*** *Doors with power operators shall be examined and tested by a testing laboratory approved by the State Fire Marshal, or tests shall be conducted by a qualified independent fire protection engineer, acceptable to the State Fire Marshal.*

(h) ***Test Report.*** *The test report shall contain engineering data and drawings; size and weight of door tested; wiring diagrams of electrical control systems; schematic drawings of mechanical controls; and operating manuals. The report shall describe the mechanical operation of the power operator in sequence as the door(s) open and close under normal and emergency conditions.*
The report shall set forth the tests performed in accordance with the provisions of this standard and the results thereof. The report shall additionally contain an analysis comparing each feature of the design against the performance test procedures contained herein.

(i) ***Simulated Installation and Test Equipment.*** *Doors with power operators shall be installed in a simulated wall and door framing assembly in accordance with the manufacturer's instructions. The test specimen shall be not less than 3 feet wide by 7 feet high. A motor-driven or suitable mechanism shall be used to actuate the activating carpet. The rate of operation or number of cycles shall be 3 to 5 per minutes. On sliding doors with a swing-out section additional operating endurance tests shall be conducted. A motor-driven mechanism or other approved means shall be used to push the swinging door section open and pull the swinging section closed at a rate of 3 to 5 cycles per minute, so that the latching mechanism and disconnect switches operate as in service. During the test the door specimen shall have only the lubrication which is provided by the manufacturer at the factory, or as may be recommended by the manufacturer in his installation instructions.*

*(j) **Endurance Tests.** The power operator shall function as intended to open and close the door(s) for 100,000 cycles of operation without failure or excessive wear of parts. The release mechanism and disconnect switches of the swinging section in sliding doors shall function as intended for 250 cycles of operation without failure or excessive wear of parts. The opening and closing forces, and the speed of opening and closing shall be recorded at the start of the endurance tests, and shall again be recorded at the end of the endurance tests. Opening and closing forces at the beginning and at the end of the endurance test shall not exceed the maximum forces prescribed in these procedures.*

HISTORY:
1. Editorial correction (Register 71, No. 52 errata sheets)

Swinging Doors Sec. 12-10-102.

(a) Each door opening when the door(s) is in the 90-degree open position, shall provide a clear opening width of not less than 28 inches, with no single leaf less than 24 inches in width.

*(b) **Doors in Pairs.** Doors in pairs shall be equipped with a separate operator for each leaf unless tests with a tandem operator with one leaf jammed in a closed and in a partially open position indicates that the second leaf continues to operate or is free to swing into the open position without exceeding the maximum permitted manual opening pressures. On doors with mechanical controls, one mechanism shall be subjected to fault conditions; during the fault condition the second leaf shall be openable manually without exceeding the maximum permitted opening pressure.*

*(c) **Closing Mechanism.** Normal closing of doors shall be by spring action, pressure-operated mechanism, or electrically driven mechanism. The closing force measured at the closing stile shall not exceed 40 pounds at any point in the closing arc. The final 10 degrees of closing shall be not less than 11/2 seconds.*

(d) Each possible fault condition that affects the power supply shall be introduced into the door and power-operator assembly. Under each fault condition, single doors and each leaf of doors in pairs shall open to the 90-degree position with an applied pressure at the normal location at the push plate not exceeding 40 pounds.

*(e) **In-swinging Doors.** Power-operated in-swinging doors are not recognized in determining exit width opening required to swing in the direction of egress.*

*(f) **Activating Carpets and Safety Mats.***

1. When carpets are used as the activating device, they shall have a width1 not less than 10 inches less than the clear width of the door opening with the centerline of the carpet in the centerline of the door opening.

2. The length2 of activating carpets shall be not less than 42 inches. The length of activating carpets for doors exceeding 42 inches in width shall be not less than 56 inches.

3. Doors serving one-way traffic only shall be provided with a safety mat3 having a length not less than the width of the widest leaf.

4. Doors serving both egress and ingress shall have a series of joined carpets on the swing side of the door arranged as follows:

A. One safety carpet or mat nearest to the door at least as long as the width of the door leaf;

B. One or more activating carpets to provide a total carpet length on the swing side of not less than 21/2 times the width of the widest door leaf.

HISTORY:
1. Editorial correction (Register 71, No. 52 errata sheets).

Sliding Doors Sec. 12-10-103.

*(a) **General.***

1. Sliding leaves of sliding doors shall be provided with swinging sections arranged to swing in the direction of egress when pressure is applied at the location of normal push plates or on the crossbar of panic hardware on doors where panic hardware is required.

2. Operation of the swinging section shall disconnect the sliding door power operator.

3. Permanent stops shall be provided to prevent double swing.

4. Location of the breakway tension adjustment, opening and closing speed adjustment, opening and closing snub speed adjustments, opening and closing power pressure adjustments, and similar controls shall be concealed and not readily accessible where they may be subject to tampering.

5. Doors shall be suspended from overhead track. Operators, control levers or mechanisms shall be guarded.

*(b) **Closing Mechanism.** The closing force of sliding doors at 24 inches of opening shall not exceed 30 pounds with a closing speed not in excess of 1.5 feet per second.*

*(c) **Opening Width.** The minimum clear width of the door opening with the swinging section, or sections in the 90-degree open position shall be not less than 28 inches with no single leaf less than 24 inches in width.*

*(d) **Opening Forces.** The swinging section in sliding doors shall swing open into the full open position when an opening force not exceeding 40 pounds is applied at the normal push plate location or on the crossbar of panic hardware.*

*(e) **Fault Condition Introduced.** Under each possible fault condition that affects the power supply with the sliding leaf or leaves retracted one-half the leaf width into its or their pocket(s) each swinging section shall open to the 90-degree position with an applied pressure at the normal location of the push plate not exceeding 40 pounds.*

*(f) **Sliding Doors Without Swing-out Section.** Power- operated sliding doors which are not provided with a swing-out section may be evaluated for conformance to the mechanical requirements and endurance tests provided in this standard. Power- operated sliding doors which are not provided with a swing-out section shall not be listed for use in locations where required exits are specified in Part 2, Title 24, California Code of Regulations.*

*(g) **Activating Carpets, Safety Mats.** Activating carpets and safety mats shall conform to Section 12-10-102 (f).*

***Marking Sec. 12-10-104.** The name of the manufacturer, or trademark by which the manufacturer can be readily identified, shall be legibly marked on the operating equipment where it can be seen after installation. The type, model number or letter designation identifying the product as a listed device shall be provided on a label attached in a location as indicated in its listing.*

Footnote

1Width: Shall be measured between the exposed edges of the carpet tread surface excluding molded edge bevels or aluminum edge trim.
2Length: Shall be measured from the centerline of the doors pivot to the exposed edge of the carpet tread surface excluding molded edge bevels or aluminum
edge trim.
3Safety Mat: A safety mat is one that will prevent the door from opening if there is pressure on the safety mat before pressure is applied to the activating mat,
and one that will prevent the door from closing following normal door actuation until pressure on the safety mat is removed.

Chapter 12-10-2
EXITS
SINGLE POINT LATCHING OR LOCKING DEVICES
STANDARD 12-10-2

STATE FIRE MARSHAL

Scope Sec. 12-10-200.

(a) ***Builders Hardware, Exit Doors.*** *These design requirements and testing procedures apply to builders hardware, single- point latches and locks, intended for use on required means of egress doors in other than Group R and M Occupancies with an occupant load of 10 or less. It is the intent that devices designed and tested in accordance with these procedures will develop data to enable the State Fire Marshal to determine the suitability of latches and locks on means of egress doors. Alternate designs and materials may be submitted with substantiating test data. If, after evaluation, devices are found to comply with the intent of these procedures, they may also be recognized for approval and listing by the State Fire Marshal.*

(b) ***Fire Doors.*** *Builders hardware single-point latches and locks intended for use on doors bearing a fire-retardant classification shall also conform to the construction standards and performance tests specified in Fire Door Assembly Tests, SFM 12-7-4, Section 12-7-400.*

(c) ***Listing by Approved Listing Agency.*** *Listing by an approved listing agency shall not be construed as necessarily indicating compliance in all respects with the requirements of these design requirements and test procedures for single-point latching or locking devices. The test report of the approved listing agency may be filed for review and after evaluation, if it is found to provide evidence of conformance, the single-point latching or locking device may be recognized for approval and listing.*

(d) ***Definitions.***
1. ***Inside knob.*** *Inside knob means the knob, lever, bar or paddle on the side of the door which must be turned or depressed to unlatch or unlock the door to permit egress.*

2. ***Outside knob.*** *Outside knob means the knob on the corridor side of room to corridor doors, or the knob on the exterior side of a door leading to the exterior.*
Instructions Sec. 12-10-201. *Approved installation instructions shall be provided by the manufacturer. Instructions shall be illustrated and shall include directions and information adequate to ensure proper and safe installation of the device.*

Design Sec. 12-10-202.
(a) ***Finish.*** *Builders hardware shall have a smooth finish with no sharp or burred edges. Knobs may be knurled or have an abrasive finish for ease of turning or identification as may be required.*
Strikes shall be plain with curved lip. Strike and lip extending beyond jamb have rounded corners.

(b) ***Knob, Lever or "T" Handle Actuated.*** *Single-point latch bolts and/or dead bolts shall be retracted from the strike to release the door by a knob, lever or "T" handle with not to exceed 1/4 turn. A thumb piece or thumb turn is not acceptable for this purpose.*

(c) ***Tested Design.*** *Builders hardware single-point latching or locking devices shall be designed to retract the latch bolt and/or dead bolt after application of the horizontal forces and the endurance tests without exceeding the releasing torque specified in 12-10-204 (h).*

(d) ***Knobs.*** *Knobs shall have a minimum diameter of 2 inches and a maximum diameter of 23/4 inches.*

(e) ***"T" Handle.*** *"T" handles shall be oval-shaped and have minimum dimensions of 13/4 inch by 1 inch at center portion with 11/4 inch projection.*

(f) ***Levers.*** *The lever of lever actuated latches or locks shall be curved with a return to within 1/2 inch of the door to prevent catching on the clothing of persons during egress.*

(g) ***Self-releasing Knob.*** *The inside knob shall be free at all times. Any locking, stopworks, or shut-out mechanism shall not prevent retracting the latch bolt or dead bolt to release the door by turning of the inside knob, or "T" handle, or depressing the inside lever, bar or paddle.*

(h) ***Dead Bolt Operation.*** *Operation of the inside knob shall retract both latch bolt and dead bolt simultaneously. The opening in the strike shall be of such dimensions that when the flat of the latch bolt is forced against the edge of the latch hole there shall be no pressure against the side of the dead bolt.*

(i) ***Springs.*** *Retraction of the latch bolt and/or dead bolt shall not depend on springs.*

(j) ***Backset.*** *Backset shall be not less than 23/4 inches or more than 5 inches.*

(k) ***Throw.*** *Latches shall have a minimum latch throw of 1/2 inch. Latches intended for use on fire endurance rated doors shall also conform to the requirements of SFM 12-7-4, Section 12-7-400, Fire Door*
Assembly Tests.

(l) ***Roller Latches.*** *Roller latches intended for use on room to corridor doors shall have a minimum projection of 3/8 inch excluding any coating or sound deadening material. Stops or staking shall be provided to provide a minimum projection of 1/8 inch. Spring design shall be such as will require an opening force of 20 pounds when the roller projects 31/6 inch in a door and frame with 1/8-inch jamb clearance. Adjustment of the roller projection shall not be possible from the front of face plate.*

Construction Materials Sec. 12-10-203.

(a) ***Cases, Interior Working Parts.*** *Cases, latch or lock enclosures, and interior working parts shall be of brass, bronze, steel, monel, stainless steel, or of materials equivalent in mechanical strength to brass or bronze. Cases of mortise locks may be of cast iron.*

(b) ***Latch Bolts, Strikes.*** *Latch bolts and strikes shall be of brass, bronze, monel, stainless steel or materials equivalent in mechanical strength having corrosion resistance equivalent to brass or bronze.*

(c) ***Corrosion Resistance.*** *Cases, enclosures and internal working parts shall have corrosion resistance equivalent to cadmium plating not less than 0. 00015 inch thick or zinc plating not less than 0.0004 inch thick, or processed to give equal corrosion resistance as determined by comparison in salt fog atmosphere per ASTM Method B-117.*

(d) ***Nonmetallic Materials.*** *Nonmetallic materials may be used as coatings or for wearing surfaces, rollers, and finishes, and antifriction inserts, or for similar purpose if the material otherwise conforms to these requirements.*

(e) ***Springs.*** *Component springs used in the assembly of a latch or lock shall be of material having spring properties equivalent to stainless steel conforming to ASTM A 313.67.*

Endurance and Performance Test Procedures

Sec. 12-10-204.

(a) ***Testing Laboratory.*** *Tests shall be conducted at a testing laboratory approved by the State Fire Marshal, or tests shall be conducted by a qualified independent fire protection engineer, acceptable to the State Fire Marshal, in testing facilities acceptable to the State Fire Marshal.*

(b) ***Report.*** *The test report shall include a detailed description of the latch or lock and its intended function; engineering data, shop drawings and photographs; identification of materials as to source, composition, strength and corrosion resistance; the physical or chemical tests including dimensions of parts before and after the endurance tests establishing conformance of materials. The report shall include the manufacturer's installation instructions. The report shall be verified by the laboratory or fire protection engineer responsible for the conduct of the test. The test report and evidence of listing by an approved listing agency may be provided for the applicable portions of these endurance and performance test procedures. Test reports prepared for other governmental agencies may be utilized to the extent that the test procedures contained herein have been duplicated.*

(c) ***Test Latches or Locks.***

1. ***Samples.*** *Samples of the test latch or lock shall be selected by the testing agency or fire protection engineer at random from the manufacturer's current production runs. The types tested shall be considered to represent, for purposes of approval and listing, all lock types of a series, except that when there are variations of basic mechanical design and/or materials for mechanical parts, each variation shall be tested for compliance with the minimum performance test procedures.*

2. ***Modifications in design or test procedure.*** *Devices involving dead-locking bolts, lever handles, shear pins in the outside know or other variations in design may require modifications in the test procedure in order to simulate the intended in-service conditions. Requests for modifications in the design and test procedures shall be filed for evaluation and approval by the State Fire Marshal before proceeding with the test.*

(d) ***Test Equipment.***

1. ***Static loading.*** *The static loading apparatus used for the torque loading, axial load, vertical load, and releasing torque tests shall consist of frame, test door, and test block as detailed in Figure 12-10-2-1. Except as shown, materials shall be of steel, welded or bolted. The test apparatus may be of alternate design and construction having equivalent or greater rigidity.*

2. ***Endurance test.*** *Apparatus for the endurance test shall consist of frame and test door as shown in Figure 12-10-2-2. An alternate design having equivalent or greater rigidity may be utilized.*
Alternate designs utilizing components of greater dimensions or greater rigidity may affect details of the approval and listing.

3. ***Test equipment.*** *Torque wrenches, spring scales, hydraulic or pneumatic pressure scales, or other instruments shall be calibrated in an approved manner.*

(e) ***Torque Loading Test.*** *Each latch or lock shall be installed in a 13/4-inch thick test block in accordance with the manufacturer's installation instructions. The test block shall be installed in the static loading test fixture. The torque load shall be applied to the inside door knob or lever. The knob or lever shall be turned or depressed to fully retract the latch bolt or dead bolt before application of the torque load. The applied torque load shall be 300 inch-pounds. After removal of the torque load the latch shall automatically return to its latch position, the dead bolt shall be extended to its locked position.*

Subsequent hand turning of the knob or depressing the lever shall retract the latch or dead bolt. Three representative latches and/or locks shall be tested and there shall be no failures.

(f) ***Axial Load.*** *Each latch or lock shall be installed as described in Section 12-10-204 (e). A hydraulic loading device or load dynamometer shall be applied first to the outside knob and then to the inside knob or lever so that the force applied to the knob or lever is in line with the axis of the spindle. The axial load applied alternately to the outside knob and inside knob or lever shall be 500 pounds. Neither knob nor lever shall pull off under the axial load. Three representative latches and/or locks shall be tested and there shall be no failures.*

(g) ***Vertical Load Test.*** *Each latch or lock shall be installed as described in Section 12-10-204 (e). Each latch or lock shall be subjected to a vertical downward force applied perpendicular to the spindle axis through a sling which shall conform to the knob shape. A vertical downward force of 350 pounds shall be applied first to the outside knob and then to the inside knob or lever. Neither knob nor lever shall break off under the downward force. Three latches or locks shall be tested and there shall be no failures.*

(h) ***Releasing Torque Test.*** *A latch or lock set shall be installed as described in Section 12-10-204 (e). A hydraulic or pneumatic loading device shall be used to apply a horizontal force of 50 pounds against the latching edge of the test block 3 inches above and in the vertical center of the latch or lock spindle in such a direction that the flat of the latch bolt is forced against the edge of the latch hole in the strike. After not less than 25 unlatchings under the above-prescribed load not more than 30 inch-pounds of torque on the inside knob in either direction or 15 pounds of downward pressure on an inside lever shall be required to retract the latch bolt. After 100,000 cycles of the endurance test as described in Section 12-10-204 (i), the torque or downward pressure necessary to retract the latch bolt shall not exceed the above-prescribed limits.*

(i) ***Endurance Test.*** *Five latches or locks shall be subjected to a accelerated endurance test as provided in this subsection. The locks shall be installed in the door of the endurance testing apparatus in accordance with the manufacturer's installation instructions. The latch or lock shall be operated to retract the latch, open the door, and close the door at a rate of approximately 10 cycles per minute. A cycle shall consist of the following:*

1. Turn the inside knob to retract the latch bolt.

2. Open the door after the latch bolt is restricted to clear the strike.

3. Release the knob allowing the latch bolt to return to its extended position by action of its own spring.
After insertion of the latches or locks in the test door the torque in inch-pounds necessary to fully retract the latch bolts shall be recorded. The torque shall be the average recorded for the five latches or locks. Each sample shall be subjected to 800,000 operating cycles as described above. Each latch shall continue to extend itself per cycle 3 above throughout the test. At the end of the endurance test the torque to retract the latch bolts of any four latch bolts shall not exceed two times the initial average torque. If two latches fail to operate successfully at the end of the test or the torque of any four latches exceeds two times the initial average torque, an additional five latches or locks shall be subjected to the endurance test and the torque of any seven latches shall not exceed two times the initial average torque.

(j) ***Roller Latches.***

1. ***Fire test.*** *Roller latches shall be installed in a composite test fire door in accordance with the manufacturer's installation instructions and subjected to the fire test as described in SFM 12-7-4, for a period of 30 minutes. The latch shall be adjusted to an opening pressure of 20 pounds applied to the closing edge immediately above the latch. Throughout the test the latch shall require an applied pressure of 20 pounds to open the door.*

2. ***Endurance test.*** *Five samples of the roller latch shall be subjected to the endurance test as described in Section 12-10-204 (i). The latch shall continue to extend the roller throughout the test without any failure. The opening pressure at the end of the test shall not be less than 15 pounds.*

3. ***Installation.*** *Doors utilizing roller latches shall be installed in doors hung in steel frames only. Frame jambs shall be anchored to the floor to prevent spreading of the jambs. In other than concrete fill floors the jambs shall be anchored to a steel sill or steel floor plate extending between the jambs to prevent spreading of the frame. Horizontal bracing shall be provided in the wall in back of the strike.*

Thickness of Coatings Tests Sec. 12-10-205. *The thickness of cadmium, zinc or bronze plated coatings applied for corrosion resistance may be determined by either of the following methods:*

1. Cross sections of coated samples cut at 90 exposed edges polished and thickness measured with a suitable microscope and scale.

2. Dropping test of a suitable reagent at a definite rate until coating is penetrated. The thickness is calculated from the known characteristics of the reagent at the observed temperature and time required for the end point to appear. Thickness testing shall not apply to other processes having equal corrosion resistance; acceptance shall be determined by comparison in salt fog atmosphere per ASTM Method B-117.

Marking Sec. 12-10-206. *The name of the manufacturer, or trademark by which the manufacturer can be readily identified, shall be legibly marked on the latch or lock where it can be seen after installation.*
When the manufacturer produces similar devices, the type, model number or letter designation identifying the listed product shall be legibly marked on the latch or case. Such identification may be an approved marking or label on the case.

FIGURE 12-10-2-1-STATIC LOADING FIXTURE

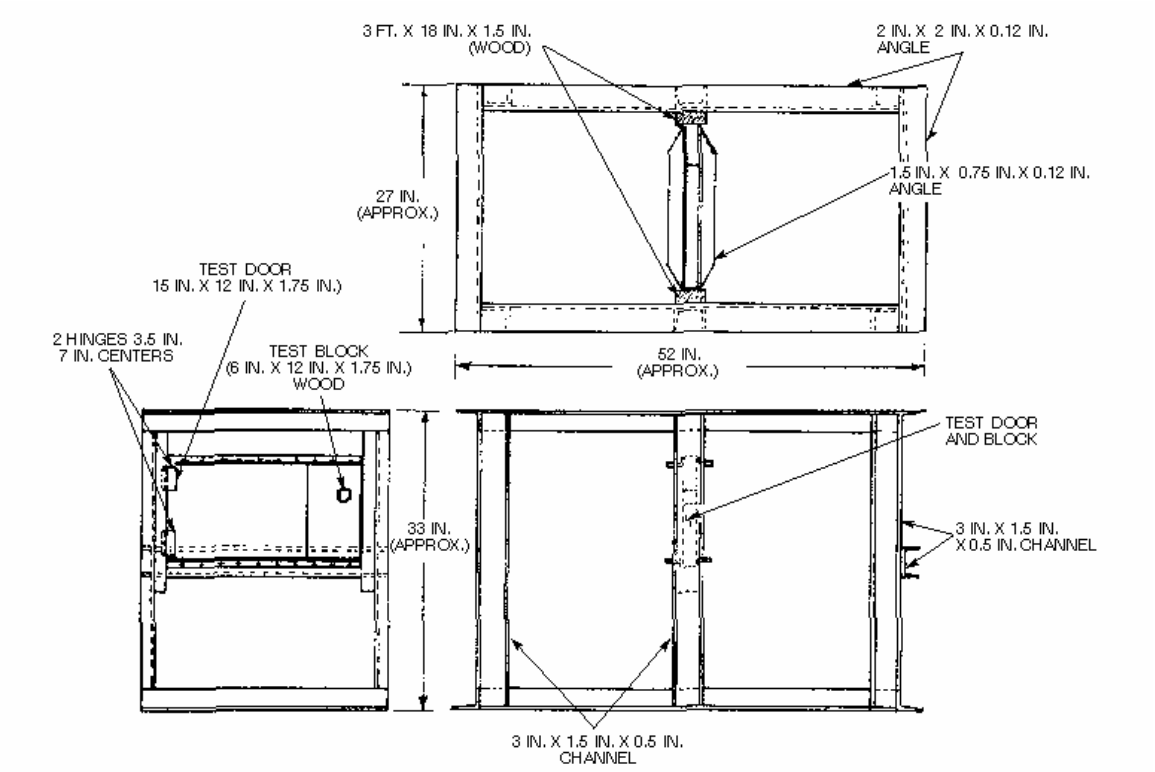
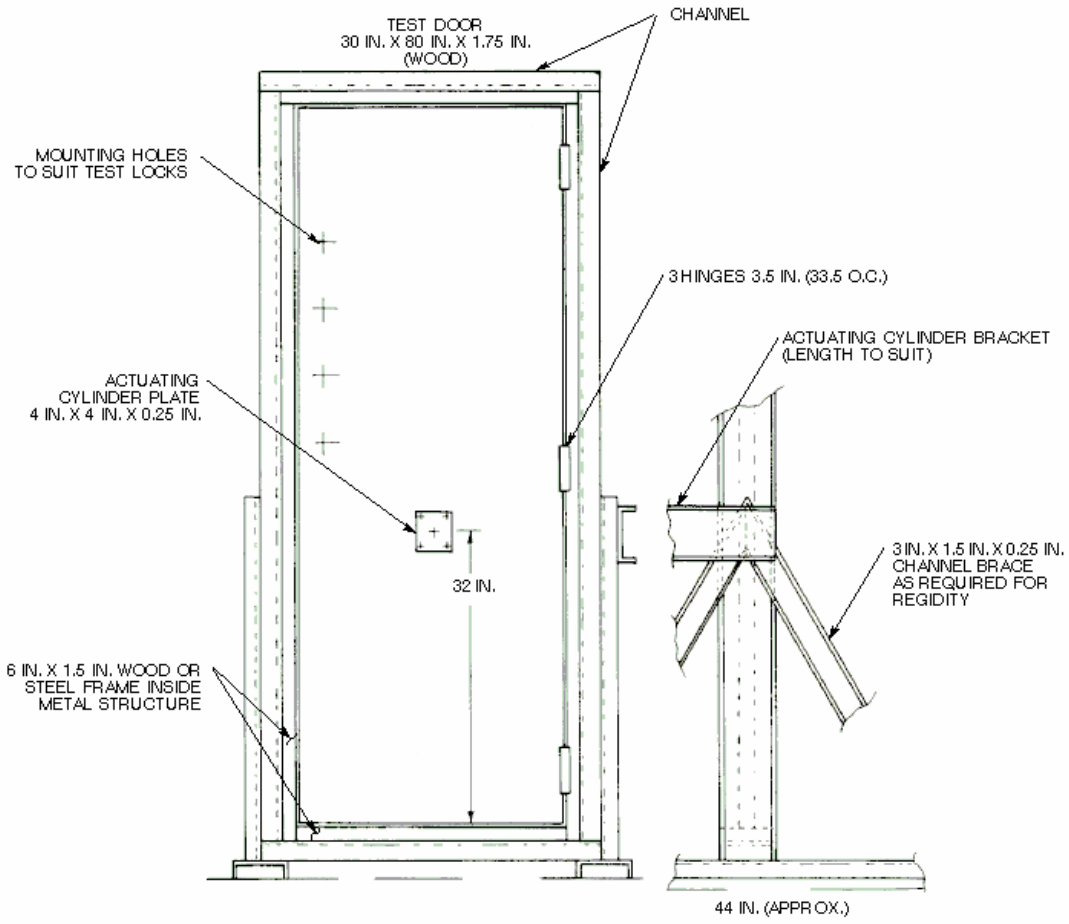


FIGURE 12-10-2-2-ENDURANCE LIFE TESTING APPARATUS



Chapter 12-10-3
EXITS
EMERGENCY EXIT AND PANIC HARDWARE
STANDARD 12-10-3

STATE FIRE MARSHAL Scope Sec. 12-10-300.

(a) ***Exit Door Hardware.*** *These requirements and methods of test apply to releasing devices actuated by a crossbar for outward- opening doors intended for use on exit doors.*

(b) ***Fire-exit Hardware.*** *Releasing devices intended for use on doors bearing a fire-retardant classification shall also conform to the construction standards and performance tests specified in Fire Door Assembly Tests, SFM 12-7-4, Section 12-7-400.*

(c) ***Listing by Approved Listing Agency.*** *Listing by an approved listing agency shall not be construed as necessarily indicating compliance in all respects with the requirements of these Construction Standards and Performance Tests for Emergency Exit and Panic Hardware. The test report of the listing agency may be filed for review and after evaluation, if it is found to provide evidence of conformance, the releasing device assembly may be recognized for approval and listing.*

Instructions Sec. 12-10-301. *Approved installation instructions shall be provided by the manufacturer. Instructions shall be illustrated and shall include directions and information adequate for obtaining proper and safe installation of the equipment.*

Design Sec. 12-10-302.

(a) ***Releasing Pressure.*** *Exit panic hardware mechanisms shall be designed to release the door latch or latches when pressure not to exceed 15 pounds is applied at any point along the cross-bar perpendicular to the door in the direction of exit travel. The cross-bar shall extend across not less than one-half the width of the door.*

(b) ***Locking Device.*** *A locking device employed as part of the mechanism shall not prevent release of the door latch or latches when pressure of not to exceed 15 pounds is applied to the cross- bar in the direction of exit travel.*

(c) ***Dead Locking Bolt.*** *A dead locking bolt shall not be provided as a part of the mechanism unless it is released and retracted, and does not prevent release of the door latch or latches, or release of the door to swing outward when pressure not to exceed 15 pounds is applied to the cross-bar in the direction of exit travel.*

(d) ***Cross Bar.*** *The ends of the cross-bar shall be curved, guarded, or otherwise designed to prevent catching on the clothing of persons during egress.*

(e) ***Springs.*** *The release mechanism shall not depend on springs to release or retract the door latch or latches, locking mechanism, dead bolt or vertical rods.*

(f) ***Dogging Devices.*** *Exit panic hardware mechanisms shall not be equipped with any locking or dogging device, set screw or other arrangement which can be used to prevent release of the door latch or latches, locking device or dead locking bolt when pressure is applied to the cross-bar.*

Construction Materials Sec. 12-10-303.

(a) ***Strength.*** *The materials used in the assembly of a releasing mechanism shall have mechanical strength equivalent to brass or bronze to perform their intended function.*

(b) ***Springs.*** *Component springs used in the assembly of a releasing mechanism shall be of material having spring properties equivalent to stainless steel conforming to ASTM A 313-67.*

(c) ***Corrosion Resistance of Moving Parts.*** *Moving parts in the releasing mechanism assembly shall have corrosion resistance equivalent to 300 series stainless steel, or shall show no visual signs of corrosion after being subjected to a salt fog atmosphere per ASTM B 117 for a period of 120 hours.*

(d) ***Nonmoving Parts.*** *Nonmoving parts, cases and similar parts shall be of materials, or shall be coated to provide corrosion protection equivalent to 0.0005-inch-thick cadmium coated steel as determined by comparison in salt fog atmosphere per ASTM B 117 for a period of not less than 16 hours.*

(e) ***Galvanic Action.*** *Coated or uncoated metals used in the assembly of releasing mechanisms shall not be used in combination such as to cause detrimental galvanic action which may adversely affect the function of any part of the assembly.*

(f) ***Nonmetallic Materials.*** *Nonmetallic materials may be used as coatings for wearing surfaces, rollers, finishes or for similar purposes if the materials otherwise conform to these requirements.*

Endurance and Performance Tests Sec. 12-10-304.

*(a) **Testing Laboratory.** Tests shall be conducted at a testing laboratory approved by the State Fire Marshal, or tests shall be conducted by a qualified independent fire protection engineer, acceptable to the State Fire Marshal in test facilities acceptable to the State Fire Marshal.*

*(b) **Report.** The test report shall include a detailed description of the releasing mechanism and its intended function; engineering data, shop drawings and photographs; identification of materials as to source, composition, strength and corrosion resistance; the physical or chemical tests including dimension of parts before and after the endurance tests establishing conformance of materials.*
The report shall include copies of the manufacturer's installation instructions. The report shall be verified by the laboratory or fire protection engineer responsible for the conduct of the test. The test report and evidence of listing by an approved listing agency may be provided for the applicable portions of these endurance and performance tests.

*(c) **Test Equipment.** The releasing mechanism shall be applied on a suitable door hung on heavy duty ball bearing butts or pivots installed in a suitable metal frame in accordance with the manufacturer's instructions. A motor-driven mechanism shall be used to actuate the cross-bar so as to release the latches or dead- locking bolts, push the door open, and jerk the door shut so that the latches or dead-locking bolts operate as in service. The rate of operation or number of cycles shall be approximately ten per minute. For the test the assembly is to have only the lubrication which is provided at the factory or as recommended by the manufacturer in his installation instructions.*

***NOTE:** Mechanisms involving dead-locking bolts may require modification in the test procedure in order to simulate the intended in-service condition. Modifications in the test procedure shall be filed for evaluation and approval before proceeding with the test.*

*(d) **Releasing Pressure.** The motor-driven mechanism shall be arranged to apply not to exceed 15 pounds pressure against the cross-bar to release the door latch(es) or dead-locking bolts before the door is pushed open.*

*(e) **Cycle Test.** The release mechanism and latches or dead- locking bolts shall function as intended for 100,000 cycles of operation without failure or excessive wear of the parts.*

Emergency Operation Test Sec. 12-10-305.

*(a) **Releasing Pressure.** The release mechanism shall be so designed that a horizontal force of 50 pounds or less will actuate the release bar and latches or dead-locking bolt when the latched or locked door is subjected to outward pressure as described in Sections 12-10-305 (c) and (d). The horizontal force shall be applied at any point along the cross-bar perpendicular to the door in the direction of swing.*

*(b) **Test Specimen.** The test specimen for the emergency operation test shall be the sample which has been previously subjected to the cycle test specified in Section 12-10-304.*

*(c) **Testing Instrument.** The horizontal force applied to the cross-bar shall be measured with a calibrated spring scale or other approved means.*

*(d) **Outward Pressure, Single Door.** A hydraulic loading device or load dynamometer shall be used to apply a horizontal force of 250 pounds against the latching edge in the direction in which the door opens. The thrust load shall be applied to the stile immediately above the latching mechanism.*

*(e) **Outward Pressure, Double Doors.** A hydraulic loading device or load dynamometer shall be used to apply a horizontal force of 250 pounds against the lock stile of each door of doors in pairs 2 inches in from the edge at midpoint between top and bottom of each door leaf in the direction of door swing.*

*(f) **Release Bar Deformation.** The cross-bar on a 36 inch wide door shall not be permanently set or deformed in excess of 1/4 inch, by the test; a spacing of at least 1 inch is to be provided and maintained between the cross-bar and the face of the door when the horizontal force is applied against the cross-bar.*

***Marking Sec. 12-10-306.** The listee's name (or approved symbol), type or model designation shall be plainly marked on the releasing assembly. Devices and assemblies which are not listed by an approved listing agency for the intended purpose shall bear a label or other identifying markings as approved by the State Fire Marshal.*

Chapter 12-71 AIR FILTERS
AIR FILTERS
STANDARD 12-71-1

STATE FIRE MARSHAL

Description of Test Apparatus, Method and Classification Requirements for Air Filters
Sec. 12-71-100.

(a) ***Test Apparatus.***

1. The test duct, made of M.S. gage galvanized sheet metal reinforced with angle irons, is 21 inches square and 131/2 feet long.

2. One end of the duct is tapered to the discharge of a variable- speed blower and the other end is open to discharge. A metal filter frame is provided near the middle of the length of the duct to receive one 20 by 20 inches (nominal) filter unit. Two tightfitting doors, located to permit access to the filter frame, are each provided with a mica window to permit observation of both faces of the filter and conditions in the duct downstream from the filter.

3. Two 1-inch pipe elbows, about 18 inches from the base of the test filter, form gas burner outlets adjusted to provide yellow, wavering flames. The burners consume approximately 4 cubic feet (approximately 1,000 Btu/cubic feet) of gas per minute.

4. With the filter in place the air velocity is adjusted to approximately 200 linear feet per minute as measured at the discharge end of the duct by an Alnor Velometer.

(b) ***Test Method.***

1. Filters are tested clean, that is, unused. The flames are applied for three minutes during which time observations are made of both faces of the filter as to the downstream travel of flame or sparks and the density, duration and character of the products of combustion.

2. Smoke density is measured as the drop in light intensity on a microammeter by means of photoelectric cell mounted a few inches below and about 12 inches inside the discharge end of the duct.
The light source, stabilized for light intensity, is mounted 1 inch above the duct directly above the photoelectric cell. The microammeter readings are recorded every five seconds for the first minute and every 10 seconds for the next two minutes.

3. The differences between these readings and the readings taken before the test are plotted against time (the scale being 40 mu a and 40 seconds to the inch) with the resulting area under the curve being measured by use of a planimeter or calculated mathematically. This area is a measure of the smoke density produced during the test.

(c) ***Classification.*** *As a result of the tests, air filter units are classified as Class 1 or 2 as indicated below:*

1. Class 1 air filter units are those which, when clean, do not produce flames or sparks when attacked by flame and which develop areas under the smoke density curves that are less than 1.5 square inches.

2. Class 2 air filter units are those which, when clean, burn moderately when attacked by flame or emit moderate amounts of smoke or both. These units, although they may be consumed to some extent, do not project flames or extensive sparks that would ignite adjacent combustible materials beyond the discharge end of the duct during the test and do not develop areas under the smoke density curves that are more than 6.0 square inches.

(d) ***Adhesive Coatings.*** *Liquid-adhesive coatings used on filters shall have a flash point of 325˚F Cleveland open cup tester, or higher.*

Chapter 12-72-1
PROTECTIVE SIGNALING SYSTEMS
PROTECTIVE SIGNALING SYSTEMS, STANDARD TEST PROCEDURES
STANDARD 12-72-1

STATE FIRE MARSHAL

Scope Sec. 12-72-100.

*(a) **Basic.** This standard represents the minimum basic requirements for the construction and performance of the protective signaling systems to be listed under this classification. The minimum design, construction and performance standards set forth herein are those deemed as minimum necessary to establish conformance to the regulations of the State Fire Marshal as set forth in the California Electrical Code, and when applicable shall be reported on in their entirety by the approved testing laboratory.*

*(b) **Systems.** This standard covers electrically operated devices and control units designed to transmit and sound alarms, supervisory and trouble signals to be employed in ordinary indoor locations in accordance with the Standards of the National Fire Protection Association for the Installation, Maintenance and Use of Proprietary, Auxiliary and Local Protective Signaling Systems, Remote Station, Nos. 72A, 72B, 72C, and 72D, and the California Electrical Code. This includes combination protective signaling systems employing nonsupervised sounding circuits; combination fire alarm-communication, -program and -clock systems (hereinafter referred to as combination signaling systems); and audible devices used for both alarm and program or communication purposes.*

*(c) **Control Unit.** A control unit covered by this standard consists of a unit assembly of electrical parts having provisions for the connection of power-supply circuits routed through the control unit equipment by a prescribed scheme of circuitry; signal initiating circuits extended to separate devices by which the operating parts of the control unit are actuated for signals, and to incorporated or separate devices by which the signals are transmitted or indicated to form a coordinated combination system for definite signaling service.*

Test Reports Sec. 12-72-101.

*(a) **Test Report Contents.** The report shall include engineering data, and an analysis comparing the design against Section 12-72-102 (a) through (u); it shall include wiring, diagrams, operating manuals and photographs as set forth in Section 12-72-102 (a), Items 5 and 6; it shall set forth the tests performed in accordance with Sections 12-72-103 (a) through (g) and the results thereof; and shall verify the correctness of the electrical rating required by Section 12-72-107.*

*(b) **Listed Devices.** Electrical wiring, material, devices, combination of devices, fittings, appliances and equipment which have been tested and listed by an approved listing agency for the intended purpose and use need not be individually retested.*
The report shall include the catalog number or other readily identifiable marking, the name of the approved listing agency, the laboratory test report number and date. Such individually tested and listed component parts and devices when installed in combination with other devices in a control unit or in a circuit extended from such control unit shall be subjected to the performance standard tests to determine its suitability for use in combination with other component parts, devices, circuits or equipment.

*(c) **Listed Control Units.** Control units which by their design are intended to fully comply with the Standard for the Installation, Maintenance and Use of Proprietary, Auxiliary, Remote Station, and Local Protective Association may be investigated and tested in accordance with the Standards for Safety established by Underwriters' Laboratories, Inc., U.L. 864, provided such investigation, test and report incorporates the provisions of the California Electrical Code.*

*(d) **Rejection for Cause.** Compliance with these standards will not necessarily mean approval and listing, if, when examined and tested, it is found to have other features which may impair the result intended by these regulations. Unusual constructions may require application of additional performance tests. The State Fire Marshal may refuse to approve any item for cause.*

*(e) **Systems Only.** The standard applies to protective signaling systems as defined in the California Electrical Code, and systems or systems components for which application for approval and listing has been filed under the provisions of the California Electrical Code. This standard does not cover manual stations, automatic detectors, automatic transmitters or other actuating devices; nor does it cover separately listed bells, registers or other indicating devices which are not provided as a part of the control unit or matched against the output of sound-reproducing equipment.*

*(f) **Differing Constructions.** A control unit having materials or forms of construction differing from this standard may be investigated and tested according to the intent of this standard, and if found to be substantially equivalent may be given recognition for approval and listing. The office of the State Fire Marshal shall be consulted for general requirements and performance standards.*

General Sec. 12-72-102.

*(a) **Investigation-Report.***

1. A control unit or combination signaling system shall be so designed and constructed as to be practical, reliable and sufficiently durable for its intended installation and use. It shall be suitable for use with acceptable actuating and indicating devices which have been found by investigation to be suitable for use with the control unit or combination signaling system. It shall permit its application in conformity with the regulations set forth in the California Electrical Code.

2. The scheme of electrical or electronic circuiting of a control unit or combination signaling system shall provide for the degree of electrical supervision required by the California Electrical Code, and when required, shall ensure emergency operation in the presence of a fault condition.

3. Attachment plugs, bells, circuit-breakers, cords, fuse- holders, fuses, lampholders, receptacles, transformers, switches, wires, etc., provided as a part of a control unit or combination signaling system shall be investigated and judged under the requirements established by the California Electrical Code, for such devices and also with respect to their suitability for the particular application.

4. Amplifiers used in the fire-protective signaling circuits of combination systems shall be tested in accordance with UL, Inc. Standard 813 (Second Edition 1954, amended 1966 and 1967), Sound Recording and Reproducing Equipment. The exchange or replacement of amplifiers from those originally tested with a combination system shall be tested in accordance with UL, Inc. Standard 813 and evaluated in accordance with this standard to determine their suitability for use with the combination system.

5. The report of investigation shall include schematic wiring diagrams tracing the electrical or electronic circuits in their normally supervised and operating condition. Contacts of operating devices shall be shown in the normally supervised position with operating and supervisory power supplied to the equipment.

6. The report of investigation shall include photographs of the equipment with markings identifying the component parts. Operating and maintenance manuals shall be included with each control unit or combination signaling system and shall be attached to the test report and certification.

7. The report of investigation shall include an itemized list of optional equipment that has, by test, been determined as not required to provide a fire alarm signal transmission. The report of investigation shall include routing of circuits for any equipment or devices which are not necessary for the transmission of a fire alarm signal.

(b) ***Marking.***

1. Control units and combination signaling systems shall be plainly and permanently marked with a nameplate bearing the manufacturer's name, model number and electrical rating. Enclosures and castings shall have die stamped or cast identifying numbers or other readily identifiable markings. Component parts shall be fully described or identified by manufacturer's name and model number.

2. A wiring diagram of the control unit or combination signaling system shall be attached inside the control cabinet or metalware enclosure.

3. An audible alarm silencing switch when provided, shall be marked to indicate its normal position unless it is of the automatically restoring type. A permanently attached metal or equivalent sign shall bear the following words, "Do not operate the audible alarm silencing switch until the fire department has been notified." The trouble signal silencing switch, unless of the automatically restoring type, shall be marked to indicate its normal on position.
4. Terminal connections for the power supply shall be marked or identified as required by the California Electrical Code.

5. Installation wiring terminals or leads shall be marked or otherwise plainly evident.

6. A control unit designed for use with automatic detectors shall be marked for use with nonrestoring types of detectors only, unless the control unit provides signal lock-in performance required by Section 12-72-103 (b), Item 14.

7. A control unit designed for use with limited-energy circuits shall be marked to identify the particular circuits in which the energy is limited.

8. The maximum impedance of each actuating circuit shall be marked when the value for successful operation is less than 100 ohms.

9. A control unit designed to limit the duration of an alarm signal by means of a time-limit cutout shall be marked to indicate the time for which it is to be adjusted; nonadjustable time-limit cutouts shall be marked to indicate time at which it will operate. [See Sections 12-72-103 (l), Items 1 and 2.]

10. Equipment required to be mounted in a definite position in order to function properly shall be marked to indicate correct mounting position.

(c) ***Frame, Enclosure and Metalware.***

1. Control units and combination signaling systems shall be installed in locked substantial cabinets or metalware enclosures and shall be of a type expressly designed for the service for which they are used. Control unit cabinets and combination signaling system metalware enclosures enclosing alarm signaling circuits shall be provided with integral key locks.

2. Control unit cabinets and combination signaling system metalware enclosures shall be so formed and assembled that they will have the strength and rigidity necessary to resist the abuses to which they are liable to be subjected, without adversely affecting their performance, and without increasing fire hazard due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

3. Electrical parts of a control unit or combination signaling system shall be so located or enclosed that suitable protection against accidental contact with uninsulated hazardous live parts will be provided.

4. Operating parts, such as gear mechanisms, relays and similar devices, shall be protected against fouling by dust, insects, or by other material which might impair their operation, by means of individual protection or dust-tight cabinets.

5. The thickness of cast metal for an enclosure shall be as indicated in Table 12-72-1A; except that cast metal of lesser thickness may be used if upon investigation it is shown that it has the equivalent mechanical strength.

6. Sheet metal enclosures for a control unit or combination signaling system shall be investigated and listed by a nationally recognized testing laboratory for its intended purpose or use, or shall be not less than indicated in Table 12-72-1B.

7. An enclosure shall have suitable means for mounting, accessible without disassembling any operating part except removal of a completely assembled panel such as a relay panel.

8. An enclosure cover shall be hinged if it gives access to fuses or any other overload-protective device, the normal functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the control unit or combination signaling system.

9. Enclosure covers accessible for service only may be unhinged if, upon investigation, they are found to be suitable for the purpose. Unhinged covers shall be securely held in place by screws or equivalent fastening devices requiring the use of a tool for its removal.
10. Cabinets or compartments for housing of primary batteries shall be key locked with provisions for protection against moisture or movement. Metal cabinets shall be of approved design constructed of sheet iron or steel not less than No. 14 manufacturer's standard gage.

11. Compartments for storage batteries shall have a total volume not less than twice the volume occupied by the batteries. Ventilating openings shall be provided, and so located to permit dispersion of gas while the battery is being charged at the highest rate permitted by the means incorporated in the unit.

12. The interior of the storage battery compartment shall be protected against detrimental action by the electrolyte. The compartment shall be so located or enclosed that the equipment of the signaling system will not be adversely affected by battery gases.

13. Ventilating openings shall be screened with wire screening having wires of not less than No. 16 AWG, expanded metal mesh or perforated metal of not less than 0.042 inch in thickness. No opening in wire screening, metal mesh or perforated metal shall exceed 1/2 square inch in area.

14. A compartment enclosing electrical parts shall not be open to the floor or other support on which the equipment rests.

(d) ***Protection against Corrosion.*** *Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating or other equivalent means. This includes all parts upon which proper mechanical operation may depend. It does not apply to bolts, screws, washers, or similar parts, if corrosion will not impair operation of the equipment. Stainless steel, polished or treated, does not require additional protection. Bearings shall be of such design and material to ensure against binding due to corrosion.*

(e) ***Insulating Materials.***

1. Base for support of live-metal parts shall be of noncombustible, moisture-resistant, insulating material commonly recognized as suitable for support of live-metal parts. A base shall withstand the most severe conditions liable to be met in service.

2. Bases mounted on metal surfaces shall be provided with an insulating barrier from the mounting surfaces unless all live-metal parts are staked, upset, sealed or otherwise prevented from loosening to prevent parts and ends of terminal screws from coming in contact with the supporting surface.

3. Countersunk, sealed parts of control units shall be covered to a depth of not less than 1/8 inch with a waterproof insulating compound which will not melt at a temperature 15˚C higher than the normal operating temperature of the assembly. In no case shall such insulating compound melt at less than 65˚C.

(f) ***Mounting Parts.***

1. All parts of control equipment shall be securely mounted in position to prevent loosening or turning if such motion may adversely affect normal operation of the control equipment. A switch, lampholder, attachment-plug receptacle or plug connector shall be mounted securely and, except as noted in Item 3, shall be prevented from turning. See Item 4.

2. The requirement that a switch be prevented from turning may be waived if all four of the following conditions are met:

A. The switch is to be of a plunger or other type that does not tend to rotate when operated (a toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch).

B. The means of mounting the switch is to make it unlikely that operation of the switch will loosen the switch.

C. The spacings are not to be reduced below the minimum acceptable values if the switch does rotate.

D. Normal operation of the switch is to be by mechanical means rather than by direct contact by persons.

3. A lamp holder of a type in which the lamp cannot be replaced (such as a neon pilot or indicator light in which the lamp is sealed in by a nonremovable jewel) need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.
4. The means for preventing the turning mentioned in Section 12-72-103 (f) is to consist of more than friction between surfaces e.g., a suitable lock washer, properly applied, is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

5. Uninsulated live-metal parts, including terminals, shall be secured by methods other than friction between surfaces, to prevent turning or shifting that may result in reduction of any required spacings. Contact assemblies shall be so secured that alignment of contacts will be ensured.

(g) ***Grounding.*** *Cabinets, metalware enclosures and noncurrent carrying metal parts shall be grounded as required by the California Electrical Code. Equipment grounded by a multiple- conductor cord shall have a fixed contacting member in the attachment plug for connection of the grounding conductor. The grounding conductor shall be green-identified and shall not be used as a circuit conductor.*

(h) ***Operating Mechanisms.***

1. Parts and motors shall be suitable for the particular applications and shall be of sufficient mechanical strength and capacity to withstand the stresses to which they will be subjected in operation without introducing any hazard.

2. Cams, signaling wheels and similar parts shall be fastened to prevent loosening or independent turning. Adjustable parts and adjusting screws shall have provisions to prevent loosening under conditions of use.

3. Electromagnetic devices shall be designed to provide positive electrical and mechanical performance under all conditions of use.

(i) ***Current-carrying Parts.***

1. Current-carrying parts shall be of nonferrous metal recognized as suitable and of sufficient mechanical strength for the particular application.

2. Except for grounded signaling wheels, bearings, hinges, etc., shall not be used for carrying current between interrelated fixed and moving parts.

(j) ***Supply Connections.*** *Control units and combination signaling systems shall be provided with wiring terminals for the connection of conductors of at least the size required by the California Electrical Code, for the electrical rating of the equipment.*

(k) ***Terminal Connections.***

1. Wiring terminals shall ensure thorough connections under hard usage. Terminals shall be a suitable pressure wire connector, firmly bolted or held by a screw, except that for No. 8 AWG and smaller wires, a wire binding screw having upturned lugs or the equivalent may be used. Alternate: Binding screws without upturned lugs may be recognized when conductors are fitted with mechanically and electrical secure ring connectors.

2. Wire-binding screws not less than 8-32 may be used at terminal strips, except that a 6-32 screw may be used for No. 14 AWG and smaller wires. Terminal plates shall be not less than 0.050 inch in thickness to provide not less than two full threads in the metal. Terminal plates of less thickness may be recognized when the resistance to stripping of the threads is equal to or greater than two full threads in 0.050-inch-thick terminal plates.

(l) ***Raceways and Power-supply Cord.***

1. Control units shall have provisions for connection of armored cable or conduit. Combination signaling systems may be provided with a flexible cord and attachment cap. The power-supply cord serving the fire alarm signal generator or tone oscillator shall be Type SJ or equivalent. Strain relief shall be provided so that mechanical stress on a flexible cord will not be transmitted to terminals, splices or interior wiring. Power-supply for the signal generator or tone ascillator provided by a cord shall have an attachment cap with a device to prevent its easy removal from the receptacle.

2. Power-supply for clock, communication or program systems shall not be supplied from the fire alarm control unit.
(m) ***Internal Wiring.***

1. Internal wiring of a control unit or combination signaling system shall consist of suitably insulated conductors for the volt age and temperature attained, and of adequate current-carrying capacity for the service.

2. All conductors in an enclosure or raceway shall be insulated for the maximum voltage of any conductor in the enclosure or raceway.

3. Wireways shall be smooth and free from sharp edges, burrs, fins and moving parts. Holes in sheet metal partitions shall be provided with smooth bushings or shall have smooth well-rounded surfaces.

4. All joints and connections shall be mechanically secure and shall provide a reliable electrical contact without strain on connections and terminals. Stranded conductors clamped under wiring- binding screws or similar parts shall have the individual strands soldered together or equivalent arrangement to ensure reliable connections.

5. Wire shall be neatly arranged and routed, and shall be held in place with clamps, string ties or equivalent unless of sufficient rigidity to retain a shaped form, placed in spaces affording protection against damage during servicing.

(n) ***Interconnection of Units.***

1. Control units and combination signaling systems shall be interconnected by metallic raceway enclosures or armored cable suitable for the purpose.

2. Cords and wires used to interconnect units within the overall enclosure shall be securely fastened to the enclosure walls by means of clamps or shall be cabled assemblies with strain relief.

3. In combination signaling systems, the control unit audible alarm circuit shall form the alarm signal interconnection. The audible alarm circuit shall be continuous to the terminals of the relay approved for alarm signaling service for the control unit, except that contacts of a combination signaling system power-supply supervisory relay may be included in the circuit.

4. The alarm signal relay shall be firmly attached to the enclosure and shall be a component part of the combination signaling system unit.

5. The interconnection between control units having nonsupervised audible alarm circuits and the combination signaling system shall be in duplicate, connected alternately to two or more signal relays wired in parallel to the oscillator or tone signal relays.

6. Portions of alarm circuits in combination signaling system control panels which are not supervised from the contacts of the audible alarm signal relay to the oscillator or tone signal alarm relays shall not exceed 24 inches in length. They shall be of 600V insulated wire held in place by clamps or equivalent and so located that they will not be subject to handling during use or servicing.

(o) ***Capacitors.*** *Capacitors shall be of materials suitable for their intended use. A paper capacitor shall be impregnated or suitably enclosed to exclude moisture. It shall not be injuriously affected by the temperature attained under the most severe conditions of use. The removal of a capacitor of the plug-in type shall require the use of a tool.*

(p) ***Coil Windings-Transformers.***

1. The insulation of coil windings of relays, transformers, etc., shall be impregnated or otherwise designed to exclude moisture.

2. Transformers connected across a power-supply circuit shall be individually housed in noncombustible material.

3. Transformers shall be of the two-coil or insulated type except that an autotransformer may be employed provided the termi nal common to both input and output circuits is connected to the grounded supply terminal.

(q) ***Overcurrent Protection.***

1. Storage batteries provided as part of a control unit, other than primary batteries, shall be protected by overcurrent devices having a rating of not less than 150 percent and not more than 200 percent of the maximum operating load on the battery.

2. System control units and combination signaling system control units shall be protected on the current supply side by overcurrent devices having a rating not more than 150 percent of the maximum normal operating current.

3. Transformers shall be protected on either the primary or secondary side by overcurrent devices having a rating not greater than the continuous duty rating of the transformer unless the current is limited to the same value by other acceptable means.

(r) ***Rectifiers.***

1. Rectifiers used direct shall be approved for the purpose and of adequate capacity to maintain voltage regulation between 100 percent of rated voltage at maximum load and 130 percent of rated voltage at no load.

2. A control unit incorporating a battery-charging rectifier shall be provided with meters as part of the assembly or with readily accessible terminal connections for portable meters for determination of battery voltage and charging current.

(s) ***Storage Batteries.***

1. Storage batteries provided as part of a control unit shall have sealed cells with spray-trap vents. Normal charging shall be by a trickle-charge rectifier. The mounting arrangement shall prevent terminals from contacting terminals of adjacent cells or parts of the battery enclosure. The cells shall permit ready access for checking the specific gravity of the electrolyte.

2. The conditioning charge shall be so limited that with the maximum charge which can be obtained, the battery gases will not adversely affect the control unit.

(t) ***Spacings.***

1. A control unit or combination signaling system shall provide reliably maintained spacings between uninsulated live-metal parts, and between uninsulated live-metal parts and dead-metal or noncurrent carrying metal parts not less than those indicated in Table 12-72-1C and Section 12-72-102 (t), Items 3 and 4.

2. The spaces within devices or assemblies which have been individually or as assemblies tested and listed by a nationally recognized testing agency for the intended use need not comply with the provisions of Table 12-72-1C and Section 12-72-102 (t), Items 3 and 4. The report shall note such devices and assemblies by reference to the test report.

3. If a short circuit between uninsulated live-metal parts of the same polarity would prevent the normal signaling operation of the control unit without simultaneously producing a trouble signal, the spacings between such parts shall be not less than those indicated for "other parts" in Table 12-72-1C except in the case of the special devices mentioned in Footnote 2 to the table, the spacing between uninsulated live-metal parts of the same polarity, for any potential of 0-300 volts, shall be not less than 1/32 inch through air, and the spacing over surface shall be not less than 1/16 inch unless the smaller over-surface spacings permitted in Footnotes 3 and 4 of Table 12-72-1C.

4. Spacings may be reduced provided a barrier or liner of suitable moisture-resistant insulating material of sufficient mechanical strength to withstand operation of equipment and arcing is used, and is reliably held in place.

*(u) **Speakers-Sound Equipment.** Speakers shall be of an approved type and designed with current capabilities for the intended function and purposes.*

Performance Sec. 12-72-103.
*(a) **General.***

1. The performance of a control unit or combination signaling system shall be investigated by subjecting a representative sample in commercial form to tests described in Sections 12-72-103 (b) through (q). Insofar as possible tests are to be made in the order indicated by the following test headings.

2. A control unit shall be tested in the position in which it is designed to be installed for proper function.

3. A combination signaling system console or rack is to be placed in a position simulating an actual installation against a vertical wood wall unless by its design, it is obviously intended for installation in the open. If ventilation openings are provided on the rear surfaces, it is to be spaced out 1 inch from the wall.

4. Tests shall be made at rated frequency and voltage. The rated voltage for test purposes is considered to be 120 volts for units marked 110-125 volts, or 240 volts if marked 220-250 volts.

5. Control units intended to be energized by trickle-charged batteries shall be tested at the rated trickle-charge of the battery except for over-and under-voltage tests.

*(b) **Normal Operation.***

1. A control unit or combination signaling system shall operate reliably and uniformly for all conditions of its intended performance when employed in conjunction with actuating devices, indicating devices, and power supplies to form a combination type indicated by the wiring diagram and supplementary information supplied with it.

2. To determine compliance, actuating devices, indicating devices optional equipment not necessary for transmission of a fire alarm signal, and power supplies are to be connected to the control unit to form a typical combination, and the control unit operated for each condition of its intended performance.

3. A combination signaling system shall be connected to the intended signal initiating control units and devices, optional equipment or devices not necessary for the transmission of a fire alarm signal, signal indicating devices (in sound-reproducing equipment the output impedance and matching load combination which produced the maximum input in the power-input test is to be used), and power supplies, and the equipment operated for each condition of its intended performance.

4. Actuating and indicating devices used for testing are to be those specified by the wiring diagram of the equipment, except that substitute devices may be used if the actuating switching contacts produce equivalent actuation, and if the indicating devices produce equivalent signal indication and circuit loading. Acceptable substitute load devices are those found by investigation to produce the same load conditions as the devices intended to be used with the equipment.

5. The control unit or combination signaling system shall be in the normal circuit supervisory condition prepared for normal signaling operation by being connected to the devices and circuits indicated in Sections 12-72-103 (b), Items 1 through 3.

6. The operation of any actuating device shall cause the equipment to operate the related indicating devices to produce a clearly defined signal of the type for which the combination is designed. 7. A coded fire alarm signal shall consist of not less than three complete rounds of the number transmitted.

8. Fire alarm signals in schools emitted by devices not distinctive in tone or used for other purposes shall be intermittent or continuous sounding signals. The signal, herein referred to as the California Uniform Fire Code Signal, shall be given for a period of ten full seconds followed by a silence of five full seconds before the signal is repeated. The signal shall be given for a period of not less than one minute. Conformance requires signal duration in excess of one minute.

9. Control units or combination signaling systems shall have provisions to disconnect time and program signal circuits upon initiation of an alarm signal. Restoration of time, recall, or program circuits shall require manual operation of a resetting device in the control unit or combination signaling system console. The resetting device shall be located inside the locked control panel or console, or shall be key-operated. A metal sign having the following words shall be attached adjacent to the switch "Reset switch shall not be operated until building has been determined safe from fire." The wiring diagram required by Section 12-72-103 (b), Item 2, shall include the circuit arrangement.
10. Combination signaling systems designed for use with a coded fire alarm control unit (control unit of type other than continuous ringing) shall be provided with an audible alarm signal relay of the lock-in type. This may be a latching-type relay or an electrical holding circuit.

11. Combination signaling systems designed for use with a continuous ringing fire alarm control unit shall be provided with a California Uniform Fire Code Signal coding device actuated by the audible alarm signal relay.

12. Combination signaling system using sound-reproducing equipment designed to provide an alarm signal of distinctive tone used for no other purpose is not required to provide a coding device. To be considered as distinctive in tone, the frequency should be not less than 300 cycles higher or lower than any other signal (such as a classroom or program signal) and shall be an undulating tone swinging not less than approximately 100 cycles each side of the mean frequency with a pulse rate of not less than 30 per minute.

13. Combination signaling systems which are so designed that they may have the power supply circuit disconnected or alarm signal output discontinued without a trouble signal shall have provisions to instantly and automatically restore power supply, signal generation and signal output upon actuation of a fire alarm initiating device.

14. The signal indicating resulting from the operation of a noncode fire alarm control unit by automatic detectors having self-restoring contacts shall be maintained automatically by the control unit until a resetting device in the control unit is manually operated.

15. Combination signaling systems designed to have the audible alarm circuit routed through a clock-cross-connect or pin board shall not, on removal or relocation of any pin, cause interruption of interference with the fire alarm signal. The circuit arrangement shall be shown on the wiring diagram required by Section 12-72-103 (b), Item 2.

16. Normal operation of fire alarm signaling equipment shall not depend upon a ground connection.

17. A switch and circuit provided for silencing alarm sounding devices shall conform to the following:

A. Switching to the off-normal position shall automatically transfer the alarm signal to visual warning signal lights which shall not be extinguished until the system is manually restored to normal.

B. With the system in normal supervisory condition, switching to the off-normal position shall result in an audible trouble signal.

C. Restoration of the alarm initiating circuit to normal supervisory condition shall result in a trouble signal, unless the silencing switch and its related control circuit is of the automatically restoring type.

D. The switch shall be located inside of the locked control unit enclosure.
18. Circuits and all related devices of a combination system may have their output regulated providing the minimum setting will allow satisfactory compliance to the California Electrical Code, for the total number of sound reproducers that may be served by the system.

(c) ***Power Input-sound Reproducing Equipment.***

1. The current or wattage consumption of a combination signaling system utilizing sound reproducing equipment shall not exceed the marked input rating by more than 5 percent when the equipment is operated under normal conditions while connected to a supply circuit of rated frequency and voltage corresponding to the mean of the marked primary voltage rating.

2. For the test specified in Section 12-72-103 (c), Item 1, the audio-input connections of each amplifier of the system are to be connected to an oscillator adjusted to supply a 1,000-cycle signal.
All volume and tone controls are to be at their maximum settings, and normal operating condition is considered to be operational with the audio-input-signal potential adjusted to produce audio- output rating of the amplifier. The tests are to be conducted throughout the range of impedance taps with load impedance of the amplifier.

(d) ***Fire Alarm Signal Precedence.***
1. Control units designed to serve more than one type of alarm- initiating device or to utilize the audible alarm devices for more than one type of signaling service shall provide priority for manual box signals, and for fire alarm signals in combination signaling systems.

2. A coded system control unit shall be actuated by one or more initiating devices other than a manual box and by a manual box simultaneously. The manual box signal shall take precedence over other signals.

3. Combination signaling system shall be actuated to transmit a program or sound signal. A fire alarm initiating device shall be actuated while the program or sound signal is being transmitted. The fire alarm signal shall take priority without any interference or garbling of the

alarm signal. Each separate type of program, or sound signal, including all-call or individual room signals shall be actuated without interfering with the fire alarm signal.

4. Fault conditions shall be introduced in each piece of optional equipment or device and during such fault conditions a fire alarm initiating device shall be actuated. The fire alarm signal shall be transmitted without interference or garbling of the alarm signal.

(e) ***Electrical Supervision.***

1. Unless otherwise provided, the circuits formed by conductors extended from the terminals of the control unit or combination signaling system shall be so electrically supervised that a trouble signal will be promptly indicated upon the occurrence of a signal break or ground fault condition of its circuits which would prevent normal operation of the combination, control unit, actuating devices and indicating devices. Electrical supervision of the main operating power, power supply to the oscillator or tone gen erator shall be provided under the conditions set forth in Sections 12-72-103 (e), Items 2 through 4. The above requirements do not apply to the following type of circuits:

A. The audible alarm signaling circuits of combination signaling system of the clock-bell program or sound reproducing type, provided all portions of the circuits are used for normal program or signaling purposes not less than once each hour.

B. Local system circuits intended for use only with sprinkler waterflow alarm or sprinkler-supervisory circuits.

C. Current and circuits for trouble signals.

D. Current for alternate operation when source of main power supply is interrupted.

E. Current supply and circuits for supplementary signal devices, or optional equipment not necessary for the transmission of a fire alarm signal, provided that a break or ground fault will not affect operation of the system for required fire alarm signals.

F. Circuit for register or indicating device provided as a part of the control unit.

G. Audible alarm circuits provided there are suitable terminal facilities for the connection of either multiple circuits, so that a break or ground fault prevents operation of only one of the circuits; or a return loop circuit so that a break or ground fault does not prevent operation of any alarm signal sounding device or appliance with means provided for testing the continuity of the circuit conductors.

H. Circuit for an alarm-indicating device in the same room as the control unit provided the circuit conductors are installed in a metallic raceway or equivalent to prevent mechanical injury or tampering.

2. Electrical supervision of the main source of operating power. Supervision of a control unit using a rectifier for battery charging shall include supervision of the power supply to the rectifier and the fuse in the load circuit of the battery.

3. Electrical supervision of the power supply to the oscillator or tone generator of a combination signaling system when the signal and its related amplifiers are used for normal room signaling service. The supervisory circuit may be so arranged as to sound the fire alarm control unit trouble signal.

4. Electrical supervision of the signal output of a combination signaling system when the alarm signal oscillator or tone generator and its related amplification devices and circuits are not used for normal signaling.
5. A single break or ground fault in an alarm initiating or indicating circuit, or failure and restoration of the power supply to the control unit, shall not cause transmission of an alarm signal.

6. To determine conformance of a control unit or combination signaling system with the performance and tests requirements of Items 1 through 5, the investigation is to start with the representative system combination in the normal supervisory condition indicated in Section 12-72-103 (b), Item 5; each type of fault to be detected shall be separately introduced in each circuit conductor.

7. If the off-normal position of any normally preset mechanism or any similar part of the control unit or control equipment requires manual restoration to normal position for proper signaling operation of the control equipment, such off-normal position shall be indicated by a trouble signal. Compliance is to be determined by observation during the normal operation test.

8. While the control unit or control equipment is in the supervisory condition, any operation of any manual-switching part that may interfere with normal operation of the equipment of transmission of an alarm signal shall be indicated by a trouble signal. The control unit or equipment shall be operated for transmission of signals in each position of the manual-switching parts.

(f) ***Trouble Signals.*** *Trouble signals shall be distinctive from alarm signals, or other communication or warning signals. They shall be indicated by the continuous sound of an audible trouble signaling device or appliance. The audible signal sounding device or appliance may be common to more than one supervised circuit. Trouble signal sounding circuits may be provided with time limit cut-off devices to provide for intermittent operation of the trouble signal device or appliance. The time limit device or appliance shall provide for the continuous sounding of the trouble signal sounding device or appliance for a period of not less than ten minutes followed by a period of silence not to exceed five minutes.*

(g) ***Trouble Signal Silencing Switch.*** *A trouble signal silencing switch shall be provided. Upon operation of the trouble signal silencing switch, the trouble indication shall be transferred to a trouble lamp or other approved visual indicator located adjacent to the silencing switch. Operation of the trouble signal silencing switch shall also remove the time limit cutout from the circuit. The visual indicator shall*

remain in operation until the silencing switch is restored to its normal position unless the audible trouble signal will be obtained when a fault occurs without restoring the switch to normal position. The silencing switch and its related control circuit may be of the automatically restoring type.

(h) ***Control Unit Input and Output Current and Voltage.***

1. The input or output current of each circuit of a control unit shall not exceed the marked rating of the control unit by more than 10 percent when the unit is operated under conditions of normal use.

2. A limited-energy detector circuit shall conform to the following:

A. The open-circuit voltage between any two wiring terminals and between any terminal and a grounded circuit part or noncurrent carrying metal part shall not exceed 50 volts when the control unit is connected to a power supply source of rated voltage and frequency.

B. Overcurrent protection not in excess of 2 amperes shall be provided in such manner that each limited-energy circuit is protected. Current-limiting transformers may be substituted provided that under condition of short circuit, current flow at the terminals will not exceed 2 amperes.

(i) ***Jarring.*** *The control unit or control equipment installed or supported in the position of its normal use connected to a power supply and in supervisory condition shall withstand jarring from impact or vibration such as may be experienced in service by striking the enclosure. Striking the enclosure shall not cause signaling operation of any part nor adversely affect any subsequent normal operation.*

(j) ***Temperature.***

1. Materials employed in the construction of a control unit or combination signaling system which have not been investigated and reported on by a nationally recognized testing laboratory as an assembly in the form intended for use shall be investigated and tested to determine temperature rises that may adversely affect the materials of construction, normal signaling operation of the equipment and fire hazard to building materials.
2. A control unit shall be mounted on a wood panel representative of its manner of installation in service. It shall be connected to a power supply as indicated in Section 12-72-103 (a), Item 4, and operated under representative normal conditions liable to produce the highest temperatures.

3. A combination signaling system shall be set up representative of normal service conditions against a wood panel wall as specified in Section 12-72-103 (a), Item 3, connected to a supply circuit as indicated in Section 12-72-103 (c), Item 1, and operated under representative normal conditions liable to produce the highest temperatures.

4. In control units equipped with time-limit cutouts which are not intended to limit the time of alarm-signal operation, the time- limit cutout shall be shunted out of the circuit for the duration of the test.

5. A control unit or combination signaling system intended to provide impulse signals shall be operated by a testing device to provide one impulse per second, except that if the signal impulses are normally produced by a device which is a part of the control unit or equipment assembly, the test impulses are to be at the rate of normal operation of the device.

6. Circuits shall be loaded representative of maximum load under normal service conditions. Resistors shall be adjusted for maximum wattage dissipation possible under conditions of normal service.

7. Except for coils, temperature readings are to be preferably obtained by means of thermocouples. Temperatures are to be considered as constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than five minute intervals, indicate no change. Temperature rise on coils may be determined by the resistance method or mercury thermometers.

8. Horizontal screened or ventilation openings subject to accumulation of dust and lint shall be covered with loose cotton.

9. Materials of construction and fire hazard to buildings shall be considered to be adversely affected if the temperature rise exceeds the limits shown in the following, based on an assumed ambient temperature of 25˚C:

A. 65˚C on wood panels or other combustible material or surfaces adjacent to or upon which a control unit may be mounted in service.

B. 35˚C on rubber or thermoplastic insulation.

C. 60˚C on varnished cloth insulation.

D. 65˚C on surface of coil winding of impregnated organic insulation.

E. 125˚C on phenolic insulation.

F. 65˚C on a transformer enclosure.

G. 65˚C on fiber insulation.

H. 30´C at any point on a copper-oxide rectifier.

I. 50´C at any point on a selenium rectifier.

J. 15´C less than melting point of a sealing compound.

K. Rated temperature limit of a capacitor.

L. 65´C on fuses.

M. 350´C on embedded resistor.

10. The test-operating condition shall be continued for a period of not less than:

A. Operation under a normal supervisory condition until constant temperatures are attained.
B. Operation for one hour during normal signaling condition of local system control equipment designed for actuation by automatic devices. Includes control units producing a continuous signal until actuating device is restored to normal or until a circuit-resetting device is manually operated.

C. Operation for 15 minutes during normal signaling condition of a local system control unit intended to be actuated by coded manual fire alarm boxes.

D. Operation of a rectifier at its maximum rated output until constant temperatures are attained.

(k) ***Over- and Under-voltage Operation.***

1. The design of a signaling system shall provide that the system will perform its intended function at 85 percent and at 110 percent of rated voltage. The operating parts of control equipment shall withstand 110 percent of its rated voltage continuously without injury during the normal supervisory condition.

2. To determine compliance with the higher voltage specified in Item 1, the signaling system is to be subjected to the increased voltage while in its normal supervisory condition until a constant temperature of all of its parts attained but in no case less than three hours and then tested for all signaling conditions. The unit shall not fail to transmit any required signal.

3. To determine compliance with the under-voltage specified in Item 1, the signaling system is to be operated in the normal supervisory condition until constant temperatures of all its parts are attained and then immediately tested for all signaling conditions at the reduced voltage. Reduced voltage is to be achieved by a means that maintains a stable potential of the required value under the most severe conditions of normal loading.

4. Circuits extended from the control unit in which the maximum impedance for successful operation is less than 100 ohms shall have the maximum impedance connected to its circuits during the under-voltage test.

(l) ***Time Limit Cutout.***

1. A time limit cutout arranged to control the duration of a continuous alarm signal shall operate within the range of the time marked for the control unit when tested at an ambient temperature of 25´C $ 2´C. A common coded signal shall complete not less than three complete rounds and a system control unit intended for schools not less than one full minute of signal transmission as specified in Section 12-72-103 (b), Item 8, before operation of the time limit cutout.

2. Except as specified in Item 1, a bell circuit time-limit-cutout shall operate in not less than three minutes nor more than ten minutes when energized continuously at the maximum rated current value of the circuit to which it is connected, tested at an ambient temperature of 25´C $ 2´C.

(m) ***Overload.***

1. Under the conditions specified in Items 2 through 4, a currentinterrupting device provided as part of, or intended for use with, a signaling system control unit or equipment shall perform in an acceptable manner during an overload test consisting of not less than 50 make and break operations. There shall be no electrical or mechanical failure of the device, nor shall there be any undue arcing, burning, pitting or welding of contacts.

2. A control unit or equipment normally supplied from a grounded circuit shall be tested with all normally grounded parts and the enclosure connected through a 15 ampere fuse to the grounded conductor of the supply circuit.

3. Current-interrupting devices controlling devices on the load side of control equipment power supply terminals shall be tested at 115 percent of rated voltage with a test load equivalent to that which the device is intended to control.

4. Overcurrent devices in control equipment which includes motor-driven devices or intended to include motors on any of its circuits shall be tested under stalled rotor conditions of the motor.

(n) ***Endurance.*** *An operating device included as part of a con bly when tested at the rate and for the number of cycles specified in Table 12-72-1D. When the device controls an electrical load the contacts shall make and break the normal current the device is intended to control for the number of cycles specified. There shall not be any electrical or mechanical failure of the device, nor shall there by any undue arcing, burning, pitting, or welding of the contacts. The device shall be tested in conjunction with its related components in the assembly by operating the primary actuating device to produce the signals.*

(o) ***Dielectric Tests.***

1. Except for motors rated at 1/2 hp or less, and 250 volts or less, signaling system control units or equipment shall withstand, without breakdown, the application of a 60-cycle alternating potential of twice rated voltage plus 1,000 volts for a period of one full minute. The test potential shall be applied to the following parts:

A. Between all normally ungrounded current-carrying parts and the enclosure.

B. Between all metal current-carrying parts and exposed noncurrent carrying parts.

C. Between all current-carrying metal parts of circuits, including transformer windings, operating at different frequencies of potentials.

2. Motors rated less than 1/2 hp and 250 volts shall withstand for one minute without breakdown, the application of a 60-cycle a.c. potential of 900 volts between the frame and winding.

(p) ***Abnormal Operation.***

1. A control unit shall be capable of operating under abnormal conditions without emission of flame, molten metal or other manifestation of a fire hazard. Excessive temperatures or burnout is indicative of failure.

2. A control unit connected to a supply circuit of rated voltage shall have its alarm initiating and audible alarm circuits short-circuited until a constant temperature is attained, or burnout occurs, unless the fault results in operation of an over current device which is an integral component part of the unit.

(q) ***Burnout Tests.***

1. A continuous-duty resistor shall not burn out or be adversely affected while carrying the maximum normal load continuously. An intermittent duty resistor shall carry its maximum rated current on any step for the maximum length of time permitted by limiting devices of the unit.

2. A transformer operated continuously, at the rated voltage and frequency specified by Section 12-72-103 (a), Item 4, with the enclosure grounded and having a load of three times maximum normal load current connected to its output terminals shall not be adversely affected by injury to the enclosure, nor shall any emission of flame or molten metal occur.

3. The testing circuit shall be protected by over current devices having a rating of at least ten times the primary current rating of the transformer. Output terminals of the transformer shall be short-circuited, if such a condition results in less than three times the maximum normal load current being drawn from the secondary. Tests shall be continued until constant temperatures are attained or a burnout occurs. Blowing of the fuse on the primary side of the transformer is not considered to be a failure.

4. If the circuit designs of a control unit or combination signaling system incorporate a time limit cutout or a mercury tube switch wired into the system circuit in such a manner that a short circuit or a ground fault causes the device to carry current in excess of its maximum normal load, it shall withstand the test specified in Items 5 through 7, without introducing a fire hazard.

5. The device is to be tested in the control equipment as it is intended to be normally used and in series with a protective fuse of the marked maximum rating indicated by the markings on the control unit. All openings in the enclosure of the control equipment shall be covered with surgical cotton, and the enclosure is to be connected to ground through a fuse of the same rating as the protective fuse mentioned above.

6. The open circuit voltage of the test circuit is to be within 5 percent of the rated voltage; see Sections 12-72-103 (a), Item 4, and 12-72-103 (c), Item 1, of the control equipment circuit in which the device is installed, except that a higher voltage may be used if agreeable to those concerned. The source of current and the test circuit should have sufficient capacity to deliver 1,000 amperes when the system is short-circuited at the testing terminals.

7. Ignition of the cotton, or of insulation on circuit conductors, emission of flame or molten metal from the enclosure, blowing of the fuse in the grounding conductor, damage to other parts of the control equipment, or any evidence of a fire hazard is to be deemed as failure. Burnout of pigtail leads or a thermal element, or welding of contacts, is not to be considered as a failure.

Printed Wiring Boards Sec. 12-72-104.

(a) ***General.***

1. These requirements cover printed wiring boards that are intended for use in fire protective signaling equipment. The acceptability of the combination of the printed wiring board and the electric equipment is to be determined by the State Fire Marshal.

2. Printed wiring boards conforming to ASTM Grade FR-5 when tested in accordance with ASTM Designation D-1867, may be used in protective signaling equipment.

3. Throughout these requirements, the term "printed wiring" is used to designate a pattern of conductive material formed in a predetermined design on the surface or surfaces of a common insulating base, and intended primarily to provide point to point electrical connections, shielding or to form inductors. The term "printed wiring board" is used to designate the combination of a printed writing pattern and the common insulating base completely processed as far as the printed portion is concerned. The term "printed wiring assembly" is used to designate a printed wiring board on which separate components have been added.

4. Printed wiring boards which do not conform to Item 3, shall be tested in accordance with the procedures set forth in Sections 12-72-104 (b) through (d).

(b) ***Insulating Material.*** *Insulating material on which printed wiring is applied shall be suitable for the sole support of uninsulated live parts and for the temperature involved, and shall have suitable mechanical strength.*

(c) ***Conductors.***

1. Current-carrying parts of printed wiring shall be of copper, copper-alloy, aluminum, silver or other material having similar corrosion-resisting properties.

2. Conductor surfaces shall be substantially free of wrinkles, pits, blisters, corrosion or other imperfections before and after being subjected to the conditions described in Item 6.

3. Printed wiring shall be so applied to the insulating material that the average strength of the bond between the printed wiring and the insulating base for each individual strip of conductor will not be less than 1 pound per inch of width of the printed wiring when samples are tested under the conditions described in Items 4 through 7.

4. The samples of printed wiring boards are to be without components (capacitors, resistors, etc.) and, except at points where connections are to be made, the conductors are to be free from solder. If the normal production soldering operation results in a coating of solder on the conductors, the samples are to be subjected to a simulated soldering operation, using a material other than solder, at the normal soldering temperature, or an equivalent arrangement, in order to obtain the same thermal effect on the conductors.

5. A uniform width of the printed wiring is to be peeled from the insulating material for a distance of 1/4 inch at a uniform rate of approximately 12 inches per minute, with the angle between the printed conductor and the insulating material at not less than 85 degrees, and the force required to separate the conductor from the insulating material measured. Three determinations are to be made on each of six samples, and the average strength of the bond for each individual strip or conductor determined.

6. Following the test described in the preceding paragraph, three of the samples are to be placed in an air oven maintained at the temperature determined by the following expression for 1,344 consecutive hours:
T = 1.02 (R + 15 + 273) - 273, where T = oven temperature in ´C.
R = temperature in ´C for which the printed material is to be recognized (75´, 90´, 105´ or 125´C).
The remaining three samples are to be placed first in the air oven for 168 hours and then in a moist air chamber having a relative humidity of 83.5-86.5 percent at a temperature of 30.5´-33.5´C, for 168 hours, and the cycle repeated for a total of 1,344 hours (four 168-hour periods in the air oven alternating with four 168-hour periods in the moist air).

7. After 1,344 hours under the conditions described in the preceding paragraph, the six samples are to be allowed to cool to room temperature and then subjected to the test described in Item 5 and the average strength of the bond determined for each sample.

8. The use of coatings over printed wiring will be given special consideration with respect to their effect on the strength of the bond between the printed wiring and the insulating material.

(d) ***Dielectric Strength.***

1. The average dielectric breakdown potential for six samples of printed wiring boards that have been conditioned in an air oven for 1,344 hours at the temperature determined by the formula in Section 12-72-104 (c), Item 6, shall be not less than 80 percent of the average dielectric breakdown potential for six samples of printed wiring boards that have not been subjected to such conditioning.

2. The 12 samples may be provided without components (capacitors, sockets, resistors, etc.) but are to be samples that have been subjected to the complete production soldering process. The test potential is to be obtained from a suitable transformer, the output voltage of which can be regulated. The potential is to be increased gradually from zero, at the rate, of approximate 75 volts per second, until dielectric breakdown occurs. Three different locations on each sample, with different spacings between conductors, if possible, are to be tested. The locations selected are to be the same for all samples. The average dielectric breakdown potentials for each group of six samples for each location is to be determined. The average value for each location for the samples that have been conditioned is to be not less than 80 percent of the average value for the corresponding location for the samples that have not been conditioned.

Relays for Protective Signaling Service Sec. 12-72-105.

*(a) **Test Conditions.** Relays which have not been qualified as approved for use with protective signaling systems by investigation and report from an approved listing agency shall have its suitability for use in a protective signaling system evidenced by an investigation and report by an approved testing laboratory which shall include certification that the relay conforms to the minimum requirements of the California Electrical Code. The test report shall include, but is not limited to:*

1. Over- and under-voltage operation per the California Electrical Code.

2. The insulation of coil windings of relays shall be such as to resist the absorption of moisture.

3. Temperature readings on the coil and insulation under normal operation at a constant temperature (temperature may be considered constant when three succeeding readings at not less than five minute intervals indicate no change in temperature).

4. Overload test consisting of 50 operations at 115 percent of rated voltage with a test load being that which the relay is to handle.

5. Endurance test consisting of 40,000 cycles of coded or noncoded signal impulses at rated load and voltage.

6. Dielectric strength test without breakdown by application of 60 cycle a.c. at twice rated voltage plus 1,000 volts for a period not less than one minute.

*(b) **Acceptance Criteria.** There shall be no electrical or mechanical failure, nor any undue pitting, burning or welding of contact during any test.*

Semiconductor Tests Sec. 12-72-106.

*(a) **General.** Semiconductors shall be investigated to determine their suitability for application under all the environmental conditions to which they will be exposed in service.*
The performance tests of the complete device are intended to show the effects of these conditions. The prescribed tests may be supplemented where conditions exceeding those represented by the tests indicated herein may be encountered.

*(b) **Test Procedure.***

*1. **Temperature.** The system combination is to be connected as in the normal operation test and operated in an oven at 85˚C. It is then to be operated in a refrigerator at 0˚C. After temperature*
equilibrium has been maintained in both cases, the unit shall operate as in the normal operation test.

*2. **Humidity.** The system combination is to be connected as in the normal operation test, and placed in a humidity cabinet maintained at 85 percent humidity, 32˚C, for a period of 48 hours. At the end of this time, the unit shall operate as in the normal operation test.*

*3. **Transient voltage.** The system combination shall be subjected to the transient voltages caused by the collapse of the field of a 2-kilovolt-ampere transformer switched on and off on a random basis for 500 cycles.*

*4. **Acceptance criteria.** There shall be no adverse effects on the system combination and the unit shall operate as intended.*

*(c) **Temperature.** A semiconductor shall be operated so as to obtain not more than 75 percent of its rated operating temperature during the normal supervisory condition indicated in Section 12-72-103 (b), Item 5. The rated operating temperature of a semiconductor shall not be exceeded under any condition of operation of the complete unit which produces the maximum temperature dissipation of its components, including the over-voltage test described in Section 12-72-103 (k), Items 1 and 2, and the variable ambient temperature test described in Section 12-72-106 (b), Item 1.*

***Electrical Rating Sec. 12-72-107.** The electrical rating of a control unit or combination signaling system shall be marked as provided in Section 12-72-102 (b). The following ratings shall be marked on the nameplate or may be marked on supplemental labels at the terminal strips:*

(a) Each power supply circuit-the voltage, frequency, and maximum input in amperes or watts.

(b) Each alarm initiating circuit-maximum current output and maximum open-circuit voltage if different than the power supply circuit.

(c) Each control unit audible alarm or indicating circuit-maximum current output and the maximum open-circuit voltage if different than the power supply circuit.

(d) Each combination signaling system sound reproducing control audible alarm circuit-output rating in watts.

(e) Supplementary-device circuit-maximum current load that may be connected, and the voltage and frequency of supply power other than that of the control unit.

(f) Fuses-maximum ampere rating of the fuse that may be installed in each fuse-holder provided as part of the control unit or combination signaling system.

TABLE 12-72-1A-CAST-METAL ENCLOSURES

DIMENSION OF AREA	Minimum Thickness in Inches	
	Die-cast Metal	Castings Other than Die-cast
24 square inches or less, no dimension greater than 6 inches	5/64*	1/2
More than 24 square inches or any dimension exceeding 6 inches	3/32	1/2
Threaded conduit opening	1/4	
Unthreaded conduit opening	1/8	1/9

*Suitable reinforcing ribs may subdivide larger areas.

TABLE 12-72-1B-SHEET-METAL ENCLOSURES

MAXIMUM DIMENSIONS		MINIMUM THICKNESS IN INCHES *		
		Steel		
Linear Dimension	Surface area in square inches	Zinc Coated	Uncoated	Copper, Brass or Aluminum
24	360	0.057 (16)	0.054 (16)	0.075 (12)
48	1,200	0.071 (14)	0.067 (14)	0.095 (10)
60	1,500	0.098 (12)	0.095 (12)	0.122 (8)
Over 60	Over 1,500	0.127 (10)	0.124 (10)	0.153 (6)

NOTE: Numbers in parentheses are the galvanized sheet gage for zinc-coated steel, manufacturer's standard gage for uncoated steel, American wire gage for non ferrous metal.

* At areas where armored cable or conduit is to be attached, sheet metal shall be of such thickness or so formed or reinforced that it will have the stiffness equivalent to uncoated flat sheet steel 0.054 inch thickness, when a supporting frame or equivalent reinforcing by forming or flanging is provided, thicknesses may be reduced by two gage numbers.

TABLE 12-72-1C-MINIMUM ACCEPTABLE SPACINGS IN INCHES

POTENTIAL INVOLVED IN VOLTS	AT INSTALLATION-WIRING TERMINALS		AT OTHER PARTS	
	Through the Air	Over the Surface of Insulating Material	Through the Air	Over the Surface of Insulating Materials
0-150	¼ (3)	¼ (3)	1/8 (4)	¼ (4)
151-300	1/8 3(3), (5)	1/8 (3)	¼ (4)	3/8 (4)
	¼ (3)			

(1) Measurements are to be made while wire with adequate capacity for the applied load is connected to each terminal as it would be in actual installation. In no case
is the wire to be smaller than No. 14 AWG.

(2) At fixed parts of rigidly clamped special assemblies of live parts and insulating separators (such as contact springs on relays or cam switches) that are wired at
the factory, the spacings may be less than those indicated, but not less than 1/16 inch for 0-150 volts, and not less than 3/32 inch for 151-300 volts, through air and over surface, except as noted in the following footnotes.

(3) Nor less than 3/64 inch through air and over surface for 250 volts or less if the equipment which the component part controls does not consume more than 375
volt-amperes or more than 5 amperes.

(4) Not less than 1/32 inch through air and over surface for a circuit involving a potential or not more than 30 volts and supplied by a primary battery or by a standard
Class 2 transformer or by a suitable combination of transformer and fixed impedance having output characteristics in compliance with what is required for a Class 2 transformer.

(5) The spacing through air at installation-wiring terminals may be less than 1/4 inch but not less than 1/8 inch if the terminals are recessed in insulating material or
have insulating barriers so as to confine loose strands of conductors sufficiently to make it unlikely that the terminals will be grounded or short-circuited.

TABLE 12-72-1D-ENDURANCE TEST

NORMAL SIGNALING PERFORMANCE OF DEVICE	***TOTAL NUMBER OF CYCLES DEVICE TO BE TESTED***	***CYCLES PER MINUTE***
Continuous noncode signal for each operation of alarm signal initiating device	*6,000*	*6*
A number of coded or noncode impulses for each operation of alarm signal initiating device	*40,000*	*60*
Preliminary coded or noncode signal impulses followed by continuous signal impulses after each operation of alarm signal initiating device	*40,000* *resetting of device after each group of 40 impulses*	*-* *60*
Relays	*40,000*	*60*

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Chapter 12–72–2

PROTECTIVE SIGNALING SYSTEMS

SINGLE AND MULTIPLE STATION FIRE ALARM DEVICES MECHANICALLY OPERATED TYPE STANDARD 12–72–2

STATE FIRE MARSHAL

Scope

Sec. 12–72–200.

(a) **Basic.** This standard represents the minimum basic requirements for the construction and performance of single– and multiple–station fire alarm devices intended for indoor installation, and to be listed under this classification. The minimum design, construction and performance standards set forth herein are those deemed as minimum necessary to establish conformance to the regulations of the State Fire Marshal.

(b) **Definitions.** For the purpose of this standard, the following definitions shall apply:

1. **Fire alarm device, multiple station.** Two or more gas–operated single station units interconnected by metal tubing to one or more remote alarm–sounding devices.

2. **Fire alarm device, single station.** A self–contained fire alarm system comprising a heat detector, an alarm–sounding device and a stored energy source incorporated in one integral package. The basic types are gas–operated units and spring–wound units.

3. **Gas–operated type.** A device having a temperature–sensitive eutectic element; compressed gas, usually in a liquid state in a cylinder; and a sounding means, such as a horn or whistle. When the eutectic element melts, the compressed gas is released in a gaseous state through the alarm–sounding device.

4. **Spring–wound type.** A device having a temperature–sensitive bimetal or eutectic element and a spring–wound type mechanism with clapper mounted within a bell housing. The snap action of the bimetal or melting of the eutectic element releases the spring mechanism resulting in a bell–type sound.

Test Reports

Sec. 12–72–201.

(a) **Test Report Contents.** The report shall include engineering data, and an analysis comparing the design against Sections 12–72–201(b) through 12–72–202(g); it shall include operating manuals and photographs. The report shall set forth the tests performed in accordance with this standard and the results thereof.

(b) **Instructions and Drawings.** A copy of the operating and installation instructions and any related drawings is to be furnished with the sample submitted for investigation to be used as a guide in the examination and test of the unit and for this purpose they need not be in final printed form.

The instructions and drawings shall include such directions and information as deemed by the manufacturer to be adequate for attaining proper and safe installation, operation and maintenance.

(c) **Rejection for Cause.** Compliance with these standards will not necessarily mean approval and listing, if, when examined and tested, it is found to have other features which may impair the result intended by these regulations. Unusual constructions may require application of additional performance tests. The State Fire Marshal may refuse to approve any item for cause. (See the California Electrical Code.)

(d) **Devices Covered.** This standard does not cover electrically operated single– or multiple–station fire alarm devices actuated by heat, smoke or combustion products.

(e) **Temperature Classification.** The temperature sensitive elements of single– and multiple–station fire alarm devices are to be identified as to their temperature of operation as follows:

TEMPERATURE CLASSIFICATION	RATING RANGE, °F (°C)	MAXIMUM CEILING TEMPERATURE, °F (°C)
Ordinary	135–174 (57–79)	100 (38)
Intermediate	175–225 (79–107)	150 (66)

The maximum rating of a fire alarm device is to be not more than 225°F (107°C).

(f) **Differing Constructions.** A control unit having materials or forms of construction differing from this standard may be investigated and tested according to the intent of this standard, and if found to be substantially equivalent may be given recognition for approval and listing. The office of the State Fire Marshal shall be consulted for general requirements and performance standards.

General

Sec. 12–72–202.

(a) **Construction.**

1. Unless otherwise indicated, the term “fire alarm device” as used in this standard refers to single– and multiple station mechanically operated type fire alarm devices.

2. A fire alarm device shall be so constructed that it will be reliable and durable for the intended installation and use.

(b) **Mounting.**

1. A fire alarm device shall be provided with a means for mounting either to a ceiling or wall.

2. The means for mounting shall not result in any distortion of the fire alarm device so as to alter its operating characteristics.

(c) **Calibration.**

1. Any means for calibration or adjustment shall be guarded or sealed to prevent manipulation by hand or ordinary tools. A thermal responsive element adjustment, if provided as part of a unit, shall not be capable of being readjusted after shipment from the factory.

2. A calibration means considered to be not accessible or apparent is one not exposed to manipulation by tools, or one not readily replaceable. The complete concealment of tool–engagement means in a screw, such as a slot, recessed head, etc., by the use of solder or brazing material is considered adequate for the purpose of preventing manipulation or replacement.

(d) **Materials.**

1. A part shall be constructed of materials that are acceptable for the intended application and shall be of adequate mechanical strength.

2. Diaphragms and spring parts shall be made of nonferrous material, such as phosphor bronze, nickel, silver, etc. or of ferrous materials. If ferrous materials are employed, they shall be hermetically sealed or plated so as not to be affected adversely by corrosion.

3. A eutectic element, if used as the operating member of a fire alarm device, shall be constructed so as not to be affected adversely by conditions to which it is likely to be exposed in service, as represented by the tests described in Section 12–72–203.

4. All exposed parts likely to be affected adversely by corrosion shall be protected by enameling, galvanizing, sherardizing, plating or equivalent means.

(e) **Operating Mechanisms.**

1. The moving parts of a fire alarm device shall have sufficient play at bearing surfaces to prevent binding.

2. The manually operated parts of a fire alarm device shall have sufficient strength to withstand the stresses to which they will be subjected in service.

3. A gear train driving spring shall be reliably anchored at each end. The spring winding means shall be provided with a positive stop to limit the winding or shall withstand the maximum force likely to be applied without affecting the operation of the mechanism adversely.

(f) **Mechanical Assembly.**

1. Any servicing or restoration operations intended to be made by the user shall be simple and capable of being accomplished with ordinary tools.

2. A device shall be so constructed that parts will not become displaced during or after installation.

3. An obstruction means, such as a wire mesh screen, shall be provided to prevent the entry of foreign bodies or materials into sounding devices which could prevent their operation.

(g) **Power Supervisory Feature.** A means shall be provided on a unit to automatically indicate that operating power is not available. The indication may be in the form of a flag, target, sight glass, change in mounting position of the fire alarm device or equivalent. A fire alarm device shall be capable of producing an alarm signal for not less than four minutes at the point where the loss of operating power is indicated initially. See Section 12–72–203 (l).

(h) **Operating Gas.**

1. The operating gas employed in a fire alarm device shall be noncombustible and shall be of a degree of toxicity that will not produce death or serious injury to guinea pigs during a two hour exposure to the gas at a concentration of $2^{1}/_{2}$ percent by volume of air.

2. Refrigerants 12 and 22 are commonly used gases which comply with this requirement.

Performance

Sec. 12–72–203.

(a) **General.**

1. Representative samples of units in commercial form shall be subjected to the following applicable tests.

2. If a device(s) is required to be mounted in a definite position in order to function properly, it shall be tested in that position.

3. If a device is normally intended to be connected to tubing to function, it shall be connected to the maximum length of tubing specified by the manufacturer unless the length of tubing would not have a bearing on its operation.

(b) **Determination of Spacings.**

1. The sensitivity of a fire alarm device is to be expressed in terms of spacing limitations. Spacing limitations refer to the maximum distance permitted between devices mounted on smooth ceilings.

2. Installation spacing limitations of a fire alarm device are developed by an oven test (15–foot spacing only) or by a fire test. See Sections 12–72–203 (c) and (d).

3. Determination of spacings is obtained by the testing of ordinary degree ratings. Devices shall be sufficiently sensitive to qualify for at least a 15–foot spacing limitation.

4. An ordinary–degree rating, with a spacing of 15 feet, may be tested for sensitivity by being subjected to the oven test. See Section 12–72–203 (c), Item 1. If the device does not operate within two minutes, a fire test shall be conducted.

5. A fire alarm device is not acceptable if it fails to qualify for at least a 15–foot spacing, i.e., does not operate within two minutes in the oven test, and does not operate when subjected to the fire test.

(c) **Oven Test.**

1. A fire alarm device shall operate in a normal and uniform manner when tested to the time–temperature curve illustrated in Figure 12–72–2–1. A sample shall be uniform in operation when mounted in the same position inside the oven. Operation is considered uniform if the device operates within a tolerance of 15°F (8.3°C) for an ordinary rated unit and 20°F (11°C) for an intermediate rated unit. A fire alarm device which operates within two minutes or less is suitable for a 15–foot spacing allocation.

2. The test apparatus consists of a full draft circulating air oven capable of producing the time–temperature curve illustrated in Figure 12–72–2–1. Air is to be moved past the sample at a velocity of 230 to 245 feet per minute. The temperature in the oven is recorded by means of a thermocouple and calibrated potentiometer.

3. The device under test is to be installed in the test oven with its temperature–sensitive element located in the air streams and positioned so that there is no obstruction of the moving air to the sensing element.

4. After installation in the oven, the device is to be subjected to the time–temperature conditions illustrated by Figure 12–72–2–1. The time of actuation is to be recorded at the instant the unit goes into alarm.

5. To determine that the performance of a fire alarm device is uniform, five samples are to be tested, using a different sample for each test, but each of the five samples is to be installed inside the chamber in the same position.

(d) **Fire Test.**

1. A fire alarm device, installed at the intended spacing, shall operate prior to the 160°F (71.1°C) rated sprinklers installed on a 10–foot spacing schedule when both are simultaneously exposed to a control fire condition.

2. The test room is to be equipped with automatic sprinkler piping arranged to receive automatic sprinklers on a 10–by–10–foot spacing schedule. Sprinklers of the standard upright spray type are to be installed with the deflectors approximately 7 inches below the ceiling, which is normal for sprinkler piping installation. For each test, new automatic sprinklers of the same make and ratings are to be installed in the sprinkler piping. The devices under test are to be installed at their designated spacing, minimum 15 feet, in line with the sprinkler and fire test plan. See Figure 12–72–2–2 for layout.

3. This test is to be conducted in a room having a smooth ceiling with no physical obstructions between the fire source and devices under test and with minimum air movement. The room is to be provided for maintaining the room temperature ambient, if necessary. The heaters are to be shut off during a test trial.

4. The room shall be of sufficient cross–sectional area so that the devices under test are located in accordance with the spacing layout illustrated by Figure 12–72–2–2. The reflection of heated air is to be prevented from returning to the devices under test from adjacent wall surfaces during the course of the fire test. The room height shall be such that the vertical distance from the base of the fire to the ceiling is approximately 12 feet.

5. Fire tests are to be produced by burning denatured alcohol consisting of 190 proof ethanol to which 5 percent methanol has been added as a denaturant, in steel pans of a size necessary to produce a temperature rise sufficient to operate the automatic sprinklers in two minutes, $\pm$ 10 seconds, when installed on a 10–by–10–foot spacing schedule. Since temperature conditions in the test room may vary throughout the year, it is necessary to utilize different pan sizes in order to obtain the proper temperature–rise condition. This test condition develops a time–temperature curve similar to that shown in Figure 12–72–2–1.

6. The fire tests are to be conducted to compare the operating time of the fire alarm devices when installed at their recommended spacing schedule as compared with the operating time of automatic sprinklers installed on the standard 10–by–10–foot spacing schedule. Operation of the devices prior to the sprinkler will qualify the device for a spacing on which it is installed. Since automatic sprinklers vary in their sensitivity, the particular sprinkler utilized in these tests is to be one which has average operating response under uniform temperature–rise conditions.

7. Four units shall be subjected simultaneously to the fire test condition and all four units are required to respond prior to the sprinkler.

8. For units which may be mounted on a side wall, the device under test shall be mounted in a vertical position so that the distance between the top of the unit and the ceiling is 6 inches. The front of the units shall face the fire source and any surfaces on which the units are mounted shall be of a configuration to prevent reflection of heat onto the detector element.

9. If a fire alarm device is intended to be mounted on the ceiling, the unit shall be so installed for this test.

10. If a device is intended to be employed with an enclosure, such as used in mounting, it shall be subjected to the fire test using the enclosure representative of normal installation.

(e) **High Temperature Exposure Test.**

1. A fire alarm device shall not operate when subjected for 30 days to the test ambient temperature indicated in Table 12–72–2A. Following the exposure the response of the units shall not show a variation of more than 10 percent from the value obtained in the Oven Test on as–received samples. There shall be no change in the sound intensity when tested following the exposure. There shall be no evidence of eutectic flow as a result of this test.

2. Devices capable of repeated operation are to be subjected to the Oven Test before and after exposure to the test temperature ambient. Where devices are not capable of repeated operation the response data after exposure is to be compared to the response of identical as–received samples.

3. A fire alarm device shall withstand the high temperature exposure without false operation and there shall be no visible deformation or change in the temperature sensitive element or any other part of the unit as a result of the test.

4. Five samples of each temperature rating are to be tested for their normal operating temperature after which they are to be placed in a circulating air oven maintained at the test temperature.

5. The units are to be removed from the oven after the 30 day period, allowed to remain at room temperature for at least 24 hours and then subjected to the oven test.

(f) **Corrosion Tests.**

1. The response of a fire alarm device, after being subjected to corrosive atmospheres, shall not show a variation of more than 50 percent from the value obtained in the oven test on as–received samples. No false alarms shall occur during the exposure and there shall be no change in the sound intensity when the units are subjected to the oven test.

2. Devices capable of repeated operations are to be subjected to the oven test before and after exposure to the corrosive atmospheres. Where devices are not capable of repeated operation, the response data obtained from the oven test is to be compared to the response of identical as–received samples.

3. Two samples are to be exposed for 10 days to an atmosphere containing approximately 1 percent hydrogen sulfide by volume in air saturated with water vapor at room temperature.

4. Two samples are to be exposed for 10 days to an atmosphere containing approximately 1 percent sulphur dioxide in 1 percent carbon dioxide by volume in air saturated with water vapor at room temperature.

5. After exposure to the corrosive atmospheres, the samples are to be removed from the test chamber, allowed to remain in a normal atmosphere at room temperature for at least 24 hours and then subjected to the oven test.

6. This test is to be conducted only on devices of the ordinary degree rating unless there is reason to anticipate different behavior of other ratings.

(g) **Operating Temperature Test.**

1. A fire alarm device shall operate in a normal manner and within the operating temperature limits and tolerances included in Table 12–72–2B, when subjected to an operating temperature test in heated water, oil or air bath.

2. Five samples of each temperature rating are to be subjected to this test. Depending on their particular design, the devices are to be suspended in a circulating water, oil or air bath, and the temperature gradually increased at the rate of 1°F (0.6°C) per minute until operation takes place. The temperature of the bath at the instant of operation is to be recorded.

(h) **Vibration Test.**

1. A fire alarm device shall be capable of withstanding vibration without false operation, without breakage or damage to parts or any leakage at fittings. Following the vibration test the response of a unit shall not show a variation of more than 50 percent from the value obtained in the oven test on as–received samples. There shall be no change in the sound intensity following the vibration.

2. Two samples are to be secured in the position of normal use on a mounting board and the board, in turn, securely fastened to a variable speed vibration machine having an amplitude of 0.01 inch. The frequency of vibration is to be varied from 10 to 35 cycles per second (cps) in increments of 5 cps until a resonant frequency is obtained. The samples are then to be vibrated at the maximum resonant frequency for a period of four hours. If no resonant frequency is obtained, the samples are to be vibrated at 35 cycles per second for a period of 120 hours.

3. For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from a position of rest or one–half of the total table displacement. Resonance is defined as the maximum magnification of the applied vibration.

4. Devices capable of repeated operation are to be subjected to the oven test before and after the vibration test. Where devices are not capable of repeated operation, the response data obtained from the oven test is to be compared to the response of identical as–received samples.

5. This test is generally to be conducted only on devices of the ordinary degree rating unless there is a reason to anticipate different behavior of other ratings. For multiple station fire alarm devices, the units shall be interconnected with a 10–foot length of tubing between units and between the units and any sounding appliance with which it is intended to be employed.

(i) **Humidity Test.**

1. A fire alarm device shall be capable of operating in a normal manner and comply with the requirements of the oven test following exposure for 24 hours to moist air having a relative humidity of 85 $\pm$ 5 percent at a temperature of 30 $\pm$ 2°C (86 $\pm$ 3.6°F). The units shall be tested within five minutes after removal from the humid environment.

2. Two samples are to be subjected to this test. This test is to be conducted on devices having an ordinary degree rating only, unless different behavior of other ratings is anticipated.

(j) **Low Temperature Exposure Test.**

1. A fire alarm device shall be capable of operating in a normal manner and comply with the requirements of the oven test following exposure for 24 hours to a temperature of minus 30 $\pm$ 2°C (minus 34.4 $\pm$ 3.6°F). The units shall be tested within five minutes after removal from the low temperature chamber. There shall be no false operation, damage to parts or leakage at fittings.

2. Two samples are to be subjected to this test. This test is to be conducted on devices having an ordinary degree rating only, unless different behavior of other ratings is anticipated.

3. For a multiple station fire alarm device the maximum length of tubing specified by the manufacturer [see Section 12–72–203 (a), Item 2] is to be connected between the unit and any alarm sounding device with which it is intended to be used prior to conducting the test.

(k) **Endurance Test.**

1. There shall be no mechanical failure of a spring wound–type fire alarm device and the unit shall be capable of operating in a normal manner and comply with the requirements of the oven test following 100 cycles of operation at a rate of not less than once per hour.

2. Two samples of any rating shall be subjected to this test. Each cycle shall consist of a complete rundown and rewinding operation. Following the 100 cycles, the units shall be subjected to the oven test.

(l) **Audibility Test.**

1. The audible alarm generated by a fire alarm device shall be distinctive in sound from other customary sounds, continue for at least four full minutes at full intensity and be not less than 83 decibels when measured in an ambient temperature of 23 $\pm$ 3°C (73. $\pm$ 5.4°F) with a relative humidity of 60 " 20 percent and a barometric pressure of approximately 700 mm mercury.

2. The measurement of sound level is to be made with a sound level meter employing the C weighting network and fast response characteristics. The measurement is to be made in a room having the approximate dimensions of 20– by 10– by 10–feet high or larger with sound absorbing panels on walls and ceiling having a Noise Reduction Coefficient (NRC) of 0.95 or higher for the walls and 0.64 or higher for the ceiling. The ambient noise level shall be not greater than 55 decibels. The device is to be mounted in a position of normal use, approximately 5 feet above the floor in the center of the room. The microphone is to be located at a 10–foot distance from the device and in a position to receive the maximum sound level produced by the device.

3. Alternately, the measurement may be made in a free field condition to minimize the effect of reflected sound energy. The ambient noise level is to be at least 10 decibels below the measured level produced by the signal device. Free field conditions may be simulated by mounting the device not less than 10 feet from the ground and with the microphone located 10 feet from the device and conducting the test outdoors on a clear day with a wind velocity of not more than 5 miles per hour and an ambient temperature of 15–25°C (50–77°F).

4. Alternatively, an anechoic chamber of not less than 1,000 cubic feet, with no dimension less than 7 feet, and with an absorption factor of 0.99 or greater from 100 Hertz (Hz) to 10 kiloHertz (kHz) for all surfaces may be used for this measurement.

(m) **Hydrostatic Strength Test.**

1. The storage cylinder of a gas operated–type detector shall be capable of withstanding, without failure, an internal hydrostatic pressure of five times the pressure of the stored gas at the operating temperature of the device.

2. In conducting the hydrostatic strength test, the storage cylinder is to be tested to the specified pressure after the shell has been completely filled with water or oil. Care should be exercised to expel all air from the test specimen before the pressure is applied.

3. The apparatus for this test is to consist of a hand– or motor–operated hydraulic pump capable of producing the required test pressure, a substantial test cage capable of containing the shell and its parts in the event of failure, the necessary valves and fittings for attachment to the test sample, a calibrated pressure gage graduated in at least 20 pounds per square inch (psi) increments to at least 200 psi more than the test pressure, and the necessary valves, fittings, etc. for regulating and maintaining the specified test pressure.

4. The pressure should be increased at a rate of approximately 300 psi per minute until the test pressure is obtained. The ultimate test pressure is to be held for one minute.

5. Five cylinders are to be subjected to this test. None of the cylinders shall rupture or show evidence of leakage. Deformation of a cylinder is not considered a failure.

Instructions

Sec. 12–72–204.

(a) **General.** Each fire alarm device shall be provided with the following installation, operating and maintenance instructions:

1. Typical installation layout for the unit(s) indicating recommended locations.

2. Description of the operation, testing (if provided), and proper maintenance procedures of the unit(s).

3. Information on establishing a household emergency evacuation plan in the event of a fire.

4. An indication that the local fire authority shall be notified of the installation.

(b) The instructions may be incorporated on the outside of the unit, on a separate sheet, or as part of a manual. If not included directly on the device, the instructions or manual shall be referenced in the marking information on the unit.

Marking

Sec. 12–72–205.

(a) **General.** A fire alarm device shall be clearly and permanently marked where it will be visible after installation with the following information. Removal of a unit from an installed position by removing not more than one screw to view the marking is considered as meeting the requirement regarding visibility after installation.

1. Name or identifying symbol of manufacturer or vendor.

2. Model number or equivalent.

3. Temperature rating of the fire alarm device.

4. Reference to the State Fire Marshal Regulations for Household Fire Warning Equipment.

5. The statement: “Do Not Paint” or equivalent to prevent painting of the temperature sensitive element and the markings. The letters shall be a minimum of $^{1}/_{8}$ inch in height.

6. The following information is required on gas operated units. The letters shall be a minimum of $^{1}/_{8}$ inch in height.

CAUTION—Pressurized Container—Do Not Puncture or Incinerate—Explosion Hazard May Result

7. The following or equivalent wording:

Operation—Responds To A Heat Producing Fire Only. Unit Will Actuate When The Temperature Of The Surrounding Air Reaches The Marked Temperature Rating (Plus Or Minus A Few Degrees) Provided The Air Temperature Increase Is 1°F (0.56°C) Per Minute Or Less. At Faster Rates Of Temperature Rise, The Surrounding Air Temperature At Which The Unit Will Actuate Will Be Above The Marked Rating, The Temperature Differential Depending On The Rate Of Rise Of Temperature Produced By A Fire. This Temperature Differential Results From the Time Lag Before The Temperature Element Absorbs The Necessary Heat From the Surrrounding Air to Actuate.

8. Instructions for setting or rewinding of a spring wound fire alarm device to be included on the device.

9. For gas–operated fire alarm devices information to return the unit to the factory for servicing shall be provided.

10. State Fire Marshal listing file number if required by Article 1.5.

(b) If a manufacturer has more than one temperature rating for an alarm device, where the thermally sensitive element is renewable and must be replaced after operation, the renewable element shall bear the manufacturer’s name or equivalent identification and the temperature rating.

(c) If a manufacturer produces units at more than one factory, each unit shall have a distinctive marking to identify it as the product of a particular factory.

Testing Oven

Sec. 12–72–206.

(a) **General.** The testing oven shall be constructed and operated in accordance with this section and the following:

1. A typical test oven consists of an oval shaped stainless steel box approximately 31 by 10 by 16 inches high, made of No. 11 M.S.G. material. One of the curved end sections is hinged. See Figure 12–72–2–3.

2. A section 6 by 6 inches at the top is fitted with a removable wooden cover.

3. Two glass windows, 4 by 6 inches in size, are provided in the sides of the oven for observation of the samples under test.

4. The interior of the oven is divided horizontally by a baffle over the heater chamber located in the central lower section. One end of the horizontal baffle is joined to a guide vane extending upward at an angle of 72 degrees into the oven chamber. The vane directs the air currents to ensure greater uniformity of temperature in the oven.

5. Eight 1,000–watt heating elements, threaded into screw shell lampholders, furnish the heat. They are so connected that six of the heating elements are controlled by means of two manually adjusted autotransformers. An auxiliary switch

controls the other two heating elements for supplying additional heat when necessary.

6. An air current through the bank of heaters is created by means of a four blade five–inch diameter fan located behind the heating elements and connected to a shaft which extends to the outside of the oven. A variable speed motor is mounted on a bracket inside the lower cabinet and operates the fan through a pulley and belt arrangement. The speed of the motor is adjusted and the pitch of the fan blade is such that the velocity of the air current is 230–245 feet per minute over the sample under test.

7. Temperatures are measured by means of two No. 30 AWG wire thermocouples inserted through copper tubes extending to the inside of the test chamber and are located adjacent to the device under test and in the heating chamber. The air velocity is measured by a velometer installed in the oven.

8. A control board is mounted on the cabinet adjacent to the testing oven. The control board incorporates five toggle switches and four indicating lights for operating the heating elements, air flow fan and a cooling fan. A toggle switch is used for turning on the temperature recorder and another is used for checking the temperatures in either the upper or lower portion of the oven.

9. Two manually adjusted autotransformers are mounted on the control panel for controlling the heat developed by the heating coils. An air flow indicator gage is incorporated on the control board for continuous indication of the air flow during the test run. In the event that the air flow tends to change during a test run, the speed of the fan is adjusted to keep the air velocity within the specified range.

(b) **Test Method.**

1. The preparation for test consists of mounting the device on the small removable screen base of $^{1}/_{4}$ inch hardware cloth formed to a height where the temperature sensing element is midway between the top of the chamber and the guide vane. The sample under test is positioned in the air stream so that there is no obstruction between the guide vane and sensing element. A spring wound device is mounted with the sensing element in a horizontal position. The test sample shall remain in the oven at least five minutes prior to starting each test run.

2. The heating coils are permitted to preheat for 10–20 seconds prior to starting the test. The fan controlling the air flow is turned on and its speed adjusted to produce the required velocity. The temperatures are read every 10 seconds. The two autotransformers are adjusted as needed to obtain the desired rate of temperature rise. Normal oven temperatures at the start of the test are to be 85–90°F (29.4–32.2°C).

3. Upon operation of the device, the current applied to the bank of heaters is cut–off and the oven is cooled to normal room temperature by means of the cooling fan.

TABLE 12–72–2A—TEMPERATURE CLASSIFICATIONS

TEMPERATURE CLASSIFICATION	RATING RANGE °F (°C)	TEST TEMPERATURE °F (°C)
Ordinary	135–174 (57–74)	125 (51.7)
Intermediate	175–225 (79–107)	150 (66)

TABLE 12–72–2B—TEST TEMPERATURES

TEMPERATURE CLASSIFICATION	OPERATING TEMPERATURE LIMITS	OPERATION	
	Minimum °F (°C)	Maximum °F (°C)	Tolerance, °F (°C)
Ordinary	128 (53.3)	165 (73.9)	10 (5.6)
Intermediate	166 (74.4)	225 (107)	15 (8.3)

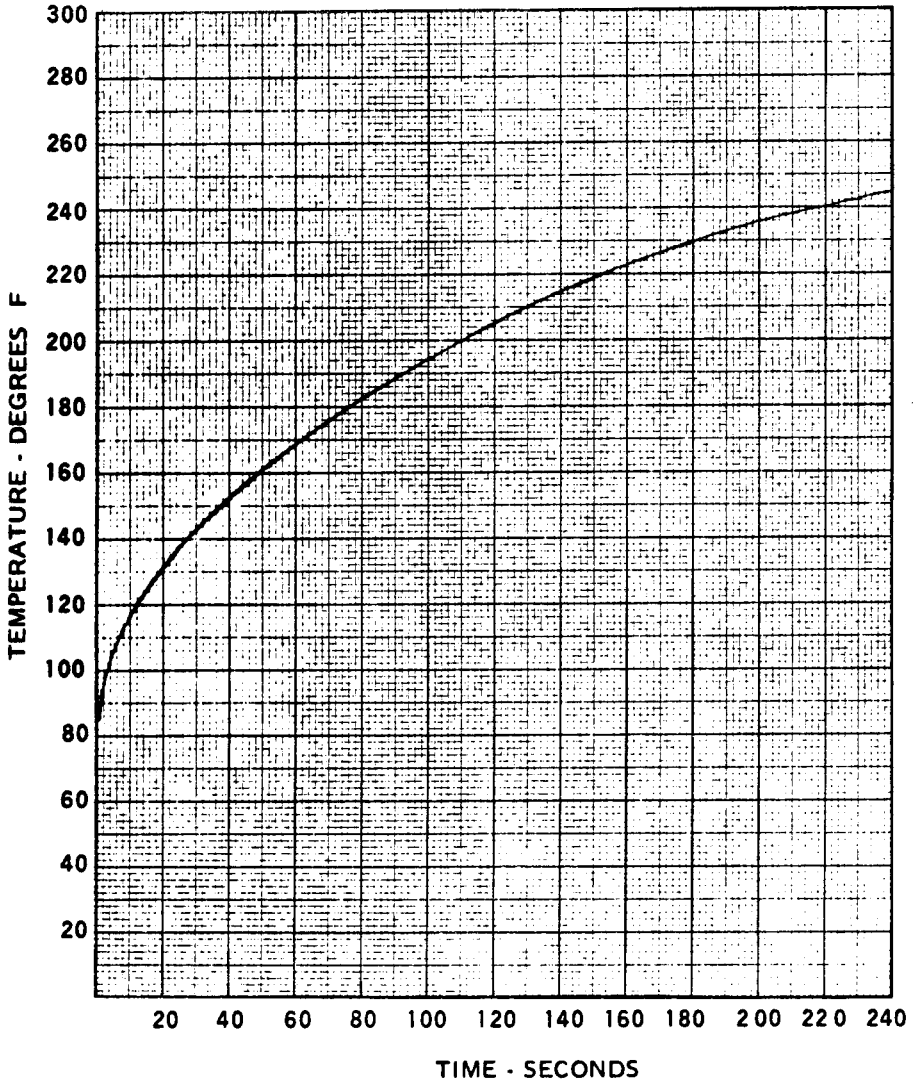
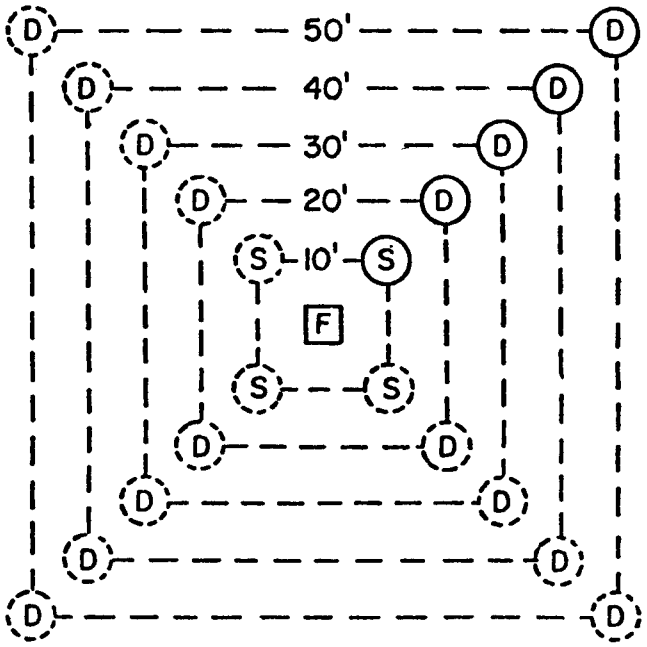


FIGURE 12–72–2–1—TIME–TEMPERATURE CURVE—15–FOOT SPACINGS



Legend:

F — TEST FIRE, DENATURED ALCOHOL, 190-PROOF.
PAN LOCATED APPROXIMATELY 3 FEET ABOVE FLOOR.

S — INDICATES NORMAL SPRINKLER SPACINGS ON 10-FOOT SCHEDULES.
SPRINKLER INSTALLED DURING FIRE TEST. RATED 160° F (71.1° C), STANDARD UPRIGHT SPRAY TYPE. DEFLECTORS APPROXIMATELY 7 INCHES BELOW CEILING.

S — INDICATES NORMAL FIRE ALARM DEVICE SPACING ON VARIOUS SPACING SCHEDULES.

D — FIRE ALARM DEVICE UNDER TEST. EMPLOYED TO DETERMINE MAXIMUM ALLOWABLE SPACING.

D —

FIGURE 12–72–2–2—FIRE–TEST LAYOUT

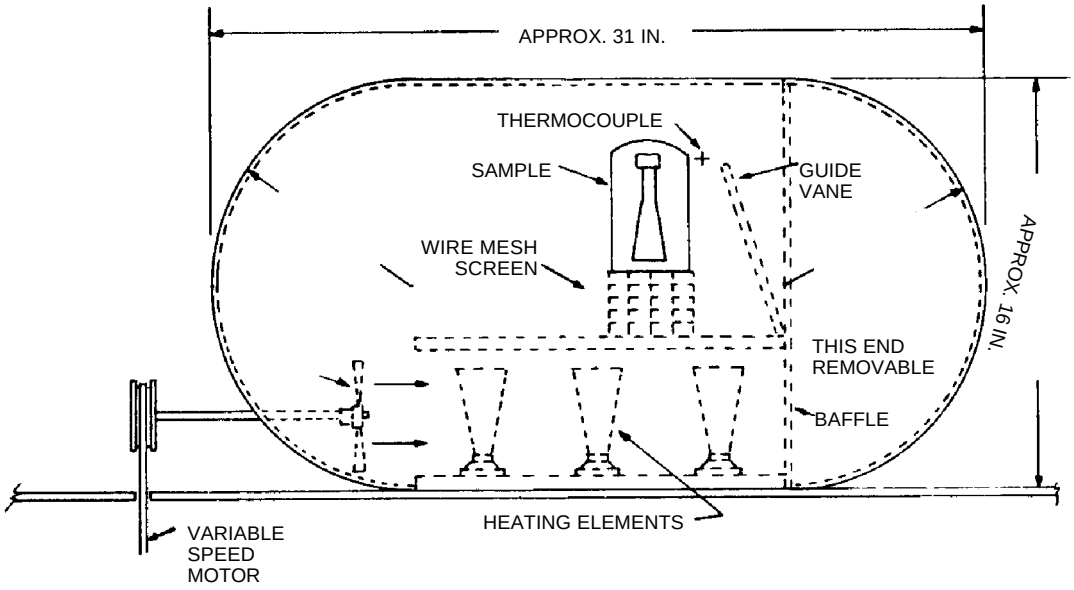


FIGURE 12–72–2–3—TEST OVEN

Chapter 12-72-3
PROTECTIVE SIGNALING SYSTEMS SMOKE DETECTORS, COMBUSTION PRODUCTS TYPE
STANDARD 12-72-3

STATE FIRE MARSHAL

Scope Sec. 12-72-300.

(a) ***Basic.*** *This standard represents the minimum basic requirements for the construction and performance of combustion products detectors of other than the photoelectric type to be employed in ordinary indoor locations and to be listed under this classification. The minimum design, construction and performance standards set forth herein are those deemed as minimum necessary to establish conformance to the regulations of the State Fire Marshal.*

(b) ***Definitions.*** *For the purpose of this standard, the following definitions shall apply:*

1. ***Alarm signal.*** *A signal intended to indicate an emergency fire condition.*

2. ***Annunciator.*** *Integrally mounted or remotely connected visual indicating device intended to indicate an alarm or trouble condition.*

3. ***Ionization type detector.*** *A device in which the presence of small combustion practices, often invisible to the eye, interfere with the normal ionization current resulting from radiation produced by a radioactive source in the detection chamber. A second chamber, employing a similar ionization source, may also be used to compensate for normal environmental ambient changes.*

4. ***Ionization-resistance bridge type detector.*** *Employs both ionization and resistance bridge principles in one unit. Additive response from both detector elements is required for detector operation.*

5. ***Resistance-bridge type detector.*** *Responds to an abnormal rate of increase of combustion products which change the impedance of second similar plate may be employed to compensate for normal ambient changes.*

6. ***Sensitivity.*** *Relative degree of response of a detector. A high sensitivity denotes response to a lower concentration of combustion than a low sensitivity under identical fire test conditions.*

7. ***Trouble signal.*** *A visual or audible signal intended to indicate a fault or trouble condition, such as an open or ground fault, occurring in the device or connected wiring.*

8. ***Voltage classification.***

A. ***Low voltage.*** *A circuit classified as low voltage is one involving a potential of not more than 30 volts alternating current (42.4 peak) or direct current, and supplied from a circuit whose power is limited to a maximum of 100 volt amperes.*

B. ***High voltage.*** *A circuit classified as high voltage is one having circuit characteristics in excess of those of a low-voltage circuit.*

Test Reports Sec. 12-72-301.
(a) The report shall include engineering data, and an analysis comparing the design against Sections 12-72-302 (a) through 12-72-302 (t); it shall include wiring diagrams, operating manuals and photographs; it shall set forth the tests performed in accordance with this standard and the results thereof and shall verify the correctness of the electrical rating.

(b) ***Listed Components.*** *Electrical wiring, material, devices, combination of devices, fittings, appliances, and equipment which have been tested and listed by an approved listing agency for the intended purpose and use need not be individually retested.*

The report shall include the catalog number or other readily identifiable marking; the name of the approved listing agency, the laboratory test report number and date. Such individually tested and listed component parts and devices shall be subjected to the performance standard tests to determine its suitability for use in combination with other component parts, devices, circuits or equipment.

*(c) **Listed Detectors.** Detectors which have been tested to any other acceptable test standard may be evaluated provided such test incorporates all features of this standard.*

*(d) **Rejection for Cause.** Compliance with these standards will not necessarily mean approval and listing, if when examined and tested, it is found to have other features which may impair the result intended by these regulations. Unusual constructions may require application of additional performance tests. The State Fire Marshal may refuse to approve any item for cause. (See the California Electrical Code.)*

*(e) **Smoke Detectors Only.***
1. A combustion products detector, as covered by these requirements consists of an assembly of electrical components arranged to detect one or more products of combustion. The products of combustion may consist of but are not necessarily limited to gaseous combustion products, water vapor and visible as well as invisible smoke particles. The detector includes provision for the connection to a source of power, signaling and optional remote control circuits.

2. These requirements cover the following types of detectors:

A. Detectors intended for open area protection, intended for connection to a compatible power supply or control unit for operation as part of a fire alarm system.

B. Detectors intended solely for control of releasing devices such as electromagnetic door holders, fire dampers, etc.

C. Detectors suitable for Items A and B above.

3. This standard does not cover the following: A. Detectors for monitoring the smoke density within flues or stacks.

B. Duct detectors.

C. Power supplies and control units to which the detectors are intended to be connected. These are covered under the Standard Test Procedures for Protective Signaling Systems, SFM 12-72-1.

D. Smoke detectors of the photoelectric type which are covered by the Standard for Smoke Detectors, Photoelectric Type, for Fire-Protective Signaling Systems, UL 168.

4. The manufacture, importation, distribution, and disposal of smoke detectors containing radioactive material are subject to the safety requirements of state radiation control agencies and/or the U.S. Atomic Energy Commission.

5. Verification of an acceptable evaluation by the regulating agency involved is required prior to the investigation of the smoke detector to ensure compliance with this standard.

*(f) **Differing Constructions.** A detector having materials or forms of construction differing from this standard may be investigated and tested according to the intent of this standard, and if found to be substantially equivalent may be given recognition for approval and listing. The office of the State Fire Marshal shall be consulted for general requirements and performance standards.*

*(g) **Operating and Installation Instructions.***

1. A copy of the operating and installation instructions and related schematic wiring diagrams and installation drawings are to be furnished with the sample submitted for investigation to be used as a guide in the examination and test of the detector and for this purpose need not be in final printed form. The information may be included in a manual or technical bulletin.

2. The instructions and drawings should include such directions and information as deemed by the manufacturer to be adequate for attaining proper and safe installation, maintenance and operation of the detector. See Section 12-72-302 (b).

General 12-72-302.

*(a) **Construction.***

1. A detector shall be so constructed that it will be reliable and sufficiently durable for its intended installation and use.

2. A component of a detector shall comply with the requirements for that component, except that such requirements may be modified if appropriate for the particular application.

3. Except where specifically indicated otherwise, the construction requirements specified for a detector shall also apply for any remote accessories with which it is to be employed.

4. Each detector is to be provided with a means for monitoring the relative sensitivity of the unit after it has been installed.

5. The monitoring means may be by means of a jack or terminals for connection of a meter, or by a visual means which would be visible with the unit installed, or equivalent.

6. The use of a plug-in type detector assembly, which may be removed readily for insertion of an adapter connected to metering equipment, would be acceptable.

(b) ***Marking.***

1. A detector shall be permanently marked with the following information, except where it is indicated that the information may appear on an installation wiring diagram.

A. Name or identifying symbol of the manufacturer or vendor.

B. Model number or equivalent and serial number or equivalent.

C. Electrical rating, in volts, amperes or watts, and frequency for each circuit. May appear on the installation wiring diagram.

D. Sensitivity setting and reference to the region of sensitivity such as maximum, nominal or intermediate or minimum. If a detector is intended to be adjusted in the field, the range of sensitivity is to be indicated. The sensitivity shall be indicated as an instrument reading. A sensitivity indication other than an instrument reading may be employed if it provides an equivalent indication of the sensitivity of the detector. May appear on the installation wiring diagram.

E. Correct mounting position if a unit is intended to be mounted in a definite position. This information may appear on the installation wiring diagram.

F. Identification of lights, switches, meters, etc. regarding their function, unless their operation is obvious.

G. Maximum rating of fuse in each fuseholder. Located adjacent to the fuseholder.

H. Reference to an installation wiring diagram, if not attached to the detector, by drawing number and issue number of date.

I. For a detector which employs a radioactive material, the following information shall be indicated directly on the unit: type, amount, radiation symbol (optional), safe disposal and a caution notice which shall read as follows:

CAUTION-Contains Radioactive Material, or its equivalent wording.

J. A reference to the Technical Bulletin. May appear on the installation wiring diagram.

K. Reference to a specific model number or description of the instrument to be used for checking the sensitivity of the detector. May appear on the installation wiring diagram.

L. A detector intended for permanent connection only to a wiring system other than metal-clad cable or conduit shall be marked to indicate the system or systems for which it is suitable. The marking shall be so located that it will be visible when power-supply connections to the detector are made or may appear on the installation wiring diagram.

M. The State Fire Marshal's listing label if required by Article 1.5.

N. A detector which is not intended to be painted in the field shall be marked on the outside "DO NOT PAINT."

2. An installation wiring diagram shall be provided with each detector illustrating the field connections to be made. The drawing may be attached to the unit or, if separate, shall be referenced in the marking attached to the unit with the drawing number and issue number and/or date.

3. The drawing shall show a pictorial view of the installation terminals or leads to which field connections are made as they would appear when viewed during an installation and the minimum internal dimensions of a back box, if not provided with the detector, shall be specified. The terminal numbers on the detector shall agree with the numbers on

the drawing. A drawing not attached to the detector unit shall be marked with the name or identifying symbol of the manufacturer's or vendor's drawing number, and an issue number and/or date.

4. The following marking information is required to appear on the detector or the installation wiring diagram for the applicable circuits to which field connections are made. Where an electrical rating is indicated, it may be omitted if reference is made for connection to a specific control unit or equivalent.

A. ***Supply circuit.*** *Voltage, current or watts, and frequency.*

B. ***Initiating device circuit connections.*** *For detectors intended to be connected only to the initiating device circuit of a fire alarm system control unit, at least two detectors shall be shown connected to a typical initiating device circuit. For a detector intended only for releasing device service, a typical connection shall be shown. For a detector suitable for both application, typical connections representing both types of connections shall be illustrated.*

C. ***Supplementary circuits.*** *Voltage, current or watts, and frequency rating.*

5. ***Technical bulletin.*** *A technical bulletin shall be provided by the manufacturer for each installation to be used as a reference by the installer. The bulletin shall include the manufacturer's recommendations regarding typical detector locations. The information shall include guidelines on detector location, spacings, maintenance, servicing tests, etc., under various environmental conditions and physical configurations. Some conditions for which guidelines are required are:*

A. Temperature
B. Humidity
C. Corrosive atmospheres
D. Air movement (ventilating and air-conditioning systems)
E. High ceilings
F. Sloped ceilings
G. Girder ceiling construction
H. Small and large bays
I. Open joist construction
J. High stock piling
K. Conditions produced by manufacturing processes

6. Detailed information shall be provided regarding the use of the facilities provided on the detector to monitor the sensitivity.

Typical information that shall be provided includes:

A. Nominal reading under clear condition.

B. Nominal reading when close to alarm.

C. Nominal reading at alarm condition.

D. Guidelines on instrument use for an engineering survey, installation and maintenance.

7. Information regarding locations where not to install detectors shall also be provided to minimize the possibility of false alarms.

8. Reference to the bulletin number and date is required either on the detector nameplate marking or on the installation drawing.
If the installation drawing is included as part of the technical bulletin, reference to the bulletin is required to be indicated on the detector.

(c) ***Frame, Enclosure and Metalware.***

1. A detector enclosure shall be so formed and assembled that it has the strength and rigidity necessary to resist the abuses to which it is likely to be subjected in service without adversely affecting its performance and without introducing a fire, shock, or accident hazard due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts or other defects.

2. Except as noted all electrical parts of a detector shall be enclosed to provide protection against contact with uninsulated live parts. A separate enclosure for field wiring terminals that will be enclosed by a back box is not required.

3. A detector shall have a suitable means for mounting, which shall be accessible without disassembling any operating part of the unit. Removal of a completely assembled panel or equivalent to mount the detector is not considered to be disassembly of an operating part.

4. An assembled part intended to be removed during installation shall be protected against damage from handling.

5. An enclosure shall have provision for the connection of metalclad cable or conduit. An enclosure without provision for the connection of metal-clad cable or conduit may be acceptable if there are furnished with it definite instructions indicating the sections of the unit which are intended to be drilled in the field for the connection of raceways, or if the unit is intended for mounting on an outlet box.

6. The thickness of cast metal for an enclosure shall be as indicated in Table 12-72-3A. Except that cast metal having a thickness 1/32 inch less than that indicated in the table may be employed if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that equivalent mechanical strength is provided.

7. If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be not less than three and one-half nor more than five threads in the metal, and the construction shall be such that a standard conduit bushing can be properly attached.

8. If threads for the connection of conduit are tapped only part of the way through a hole in an enclosure wall, there shall be not less than three and one-half full threads in the metal, and there shall be a smooth, rounded inlet hole for the conductors which shall afford protection to the conductors equivalent to that provided by a standard conduit bushing.

9. ***Sheet metal enclosures.*** *The thickness of sheet metal employed for the enclosure of a detector shall be not less than that indicated in Table 12-72-3B, except that sheet metal of two gauge sizes lesser thickness may be employed if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape and/or size of the surface is such that equivalent mechanical strength is provided.*

10. At any point where conduit or metal-clad cable is to be attached, sheet metal shall be of such thickness or shall be so formed or reinforced that it will have a stiffness at least equivalent to that of an uncoated flat sheet steel having a minimum thickness of 0.053 inch (No. 16 MSG).

11. A plate or plug closure for an unused conduit opening or other hole in the enclosure shall have a thickness not less than:

A. 0.014 inch for steel or 0.019 inch for nonferrous metal for a hole having a 1/4-inch maximum dimension.

B. 0.027-inch steel or 0.032-inch nonferrous metal for a hole having a 13/8-inch maximum dimension.

12. A closure for a hole larger than 13/8-inch diameter shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

13. A knockout in a sheet metal enclosure shall be reliably secured but shall be capable of being removed without undue deformation of the enclosure.

14. A knockout shall be provided with a surrounding surface adequate for proper seating of a conduit bushing, and shall be so located that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those indicated under spacings. The figures in parentheses are the galvanized sheet gage numbers (GSG) (for zinc-coated steel), the manufacturers' standard gage numbers (MSG) (for uncoated steel), and the American wire gage numbers (AWG) (for a nonferrous metal) which provide the required minimum thickness of metal.

15. An enclosure or parts of an enclosure of nonmetallic material shall have the mechanical strength and durability and be so formed that parts will be protected against damage. The mechanical strength of an enclosure shall be at least equivalent to a sheet metal enclosure of the minimum thickness specified in Table 12-72-3B. See Section 12-72-205 for performance tests on plastic materials and enclosures.

16. (No requirements.)

17. The continuity of the grounding system shall not rely on the dimensional integrity of the nonmetallic material.

18. Ventilating openings in an enclosure, including perforated holes, louvers and openings protected by means of wire screening, expanded metal or perforated covers, shall be of such size or shape that no opening will permit passage of a rod having a diameter of 33/64 inch. An enclosure for fuses or other overload protective device and provided with ventilating openings shall afford adequate protection against the emission of flame or molten metal. The opening shall be designed to permit cleaning without damage to functional enclosed parts.

19. Except as noted in the following paragraph, perforated sheet metal and sheet metal employed for expanded metal mesh shall be not less than 0.042 inch in average thickness, 0.046 inch if zinc coated.

20. If the indentation of a guard or enclosure will not alter the clearance between uninsulated live parts and dead metal parts so as to affect performance adversely or reduce spacings below the minimum values given under spacings, 0.021 inch expanded metal mesh (0.024 inch if zinc coated) may be employed, provided that (1) the exposed mesh on any one side or surface of the device so protected has an area of not more than 72 square inches and has no dimension greater than 12 inches, or (2) the width of an opening so protected is not greater than 31/2 inches.

21. The wires forming a screen protecting current carrying parts shall be not smaller than No. 16 AWG and the screen openings shall be not greater than 1/2 square inch in area.

22. An enclosure cover shall be hinged, sliding, pivoted or similarly attached if (1) it provides ready access to fuses or any other overcurrent protective device the normal functioning of which requires renewal, or (2) it is necessary to open the cover in connection with the normal operation of the unit.

23. With reference to the requirement of Item 22, normal operation is considered to be operation of a switch for testing or for silencing an audible signal appliance or operation of any other component of a unit which requires such action in connection with its intended performance.

24. A hinged cover is not required where the only fuse(s) enclosed is intended to provide protection to portions of internal circuits, such as may be employed on a separate printed wiring board or circuit subassembly, to prevent excessive circuit damage resulting from a fault. The use of such a fuse(s) is acceptable if the following or equivalent marking is indicated on the cover of units employing high voltage circuits: Circuit Fuse(s) Inside-Disconnect Power Prior to Servicing.

25. A hinged cover shall be provided with a latch, screw or catch to hold it closed. An unhinged cover shall be securely held in place by screws or the equivalent.

26. Glass covering an observation opening shall be held securely in place so that it cannot be readily displaced in service and shall provide adequate mechanical protection of the enclosed parts. The thickness of a glass cover shall be not less than that indicated in Table 12-72-3C.

27. A glass panel for an opening having an area of more than 144 square inches or having any dimension greater than 12 inches, shall be supported by a continuous groove not less than 3/16 inch deep along all four edges of the panel.
28. A transparent material other than glass employed as a cover over an opening in an enclosure shall have mechanical strength equivalent to that of glass, not become a fire hazard or distort, or not become less transparent at the temperature to which it may be subjected under normal or abnormal service conditions.

(d) ***Protection against Corrosion.***

1. Except as indicated herein, iron and steel parts shall be suitably protected against corrosion by enameling, galvanizing, sheradizing, plating or other equivalent means.

2. These requirements apply to all enclosures whether of sheet steel or cast iron, and to all springs and other parts upon which proper mechanical operation may depend. It does not apply to minor parts such as washers, screws, bolts and the like, if the failure of such unprotected parts would not be liable to result in a hazardous condition or adversely affect the operation of the unit. Parts made of stainless steel (properly polished or treated if necessary) do not require additional protection against corrosion. Bearing surfaces should be of such materials and design as to ensure against binding due to corrosion.

(e) ***Insulating Materials.***

1. Material for the mounting of current-carrying parts shall be porcelain, phenolic composition, cold-molded composition or material which is suitable for the particular application.

2. Vulcanized fiber may be used for insulating bushings, washers, separators and barriers, but not as the sole support for uninsulated current-carrying parts of other than low-voltage circuits.

Plastic materials may be used for the sole support of uninsulated live parts, if found to have adequate mechanical strength and rigidity, dielectric withstand, resistance to heat, flame propagation, arcing, creep and moisture, and other properties suitable for the application, without displaying a loss of these properties beyond the minimum acceptable level as a result of aging.

3. Metal parts as described below need not comply with the requirement of Section 12-72-302 (d), Item 2.

A. Adhesive attached metal foil markings, screws, handles, etc., which are located on the outside of the detector enclosure and isolated from electrical components or wiring by grounded metal parts so that they are not liable to become energized.

4. A terminal block mounted on a metal surface which may be grounded shall be provided with an insulating barrier between the mounting surface and all live parts on the underside of the base which are not staked, upset, sealed or equivalently prevented from loosening so as to prevent such parts and the ends of replaceable terminal screws from coming in contact with the supporting surface.

5. A countersunk part shall be covered with a waterproof insulating compound which will not melt at a temperature 15? C (27? F) higher than the maximum normal operating temperature of the assembly, and at not less than 65? C (149? F) in any case. The depth or thickness of sealing compound shall be not less than 1/8 inch.

(f) ***Mounting Parts.***

1. All parts of a detector shall be securely mounted in position and prevented from loosening or turning if such motion may affect adversely the normal performance of the unit, or may affect the fire and accident hazard incident to the operation of the detector.

2. A switch, lampholder, attachment-plug receptacle, plug connector or similar electrical component, shall be mounted securely and, except as noted in Items 3 and 4, shall be prevented from turning.

3. The requirement that a switch be prevented from turning may be waived if all four of the following conditions are met:

A. The switch is to be of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.

B. Isolated metal parts, such as small assembly screws, etc., which are positively separated from wiring and uninsulated live parts.

C. Panels and covers which do not enclose uninsulated live parts if wiring is positively separated from the panel or cover so that it is not liable to become energized.

D. Panels and covers which are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition or similar material not less than 1/32-inch thick and reliably secured in place.

4. A bonding conductor shall be of material suitable for use as an electrical conductor. If of ferrous metal, it shall be protected against corrosion by painting, plating or the equivalent. The conductor shall be not smaller than the maximum size wire employed in the circuit wiring of the component or part. A separate bonding conductor or strap shall be installed in such a manner that it is protected from mechanical damage.

5. The bonding shall be by a positive means, such as by clamping, riveting, bolted or screwed connection, brazing, or welding. The bonding connection shall reliably penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material.

6. A bolted or screwed connection that incorporates a star washer under the screw head, is considered acceptable for penetrating nonconductive coatings.

7. Where the bonding means depends upon screw threads, two or more screws or two fall threads of a single screw engaging metal is considered acceptable.

8. Metal-to-metal hinge-bearing members for doors or covers may be considered as a means for bonding the door or cover for grounding providing a multiple-bearing, pin-type hinge is employed.

9. Splices shall not be employed in conductors used to bond electrical enclosures or components.

(g) ***Deleted.***

(h) ***Motors.***

1. All motors shall be protected by thermal or by overcurrent protective devices, or a combination thereof.

2. A motor employing thermal protection which complies with the Standard for Thermal Protectors for Motors, UL 547, is considered to comply with the requirement of Item 1.

3. Motors, such as direct-drive fan motors, which are not normally subjected to overloads, and which are determined to be adequately protected against overheating due to locked-rotor current by a thermal or overcurrent protective device may be accepted under this requirement, provided it is determined that the motor will not overheat under the performance requirements of this standard.

4. Impedance protection may be accepted for motors which are determined to be adequately protected against overheating due to locked-rotor current, provided it is determined that the motor will not overheat under the performance requirements of this standard.

(i) ***Current-carrying Parts.***

1. A current-carrying part shall have adequate mechanical strength and current carrying capacity for the service, and shall be a metal such as silver, copper or copper alloy, or other material which will provide equivalent performance.

2. Bearings, hinges, etc., are not acceptable for carrying current between interrelated fixed and moving parts.

3. The insulation of coil windings of relays, transformers, etc., shall be such as to resist the absorption of moisture.

4. Enameled wire is not required to be given additional treatment to prevent moisture absorption.

(j) ***Supply Connections.*** *A detector shall be provided with wiring terminals or leads for the connection of conductors of at least the size required by the California Electrical Code, corresponding to the rating of the unit.*

(k) ***Terminal Connections and Leads.***

1. The parts to which wiring connections are made are to consist of binding screws with terminal plates having upturned lugs or the equivalent to hold the wires in position. Other terminal connections may be provided if found to be equivalent.

2. If a wire binding screw is employed at a field wiring terminal, the screw shall be not smaller than No. 8, except that a No. 6 screw may be used for the connection of a No. 14 AWG or smaller conductor.

3. Except as noted in the following paragraph, a terminal plate tapped for a wire binding screw shall be of metal not less than 0.050 inch in thickness for a No. 8 or larger screw, and not less than 0.030 inch in thickness for a No. 8 screw, and shall have not less than two full threads in the metal.

4. A terminal plate may have the metal extruded at the tapped hole for the binding screw so as to provide two full threads. Other constructions may be employed if they provide equivalent security.

5. Leads provided for field connections shall be not less than 6 inches long, provided with strain relief, shall be not smaller than No. 18 AWG, and the insulation, if of rubber or thermoplastic, shall be not less than 1/32 inch in thickness.

6. The leads specified in Item 5 may be less than 6 inches in length if it is evident that the use of a longer lead might result in a hazard.

7. In a detector intended for connection to a high-voltage source of supply by means of other than a metal-enclosed wiring system, such as nonmetallic sheathed cable:

A. An equipment-grounding terminal or lead shall be provided.

B. A marking shall be provided to indicate the system or systems for which it is suitable. (See Item 1, L of Section 12-72-302 (b).

C. The grounding means shall be reliably connected to all exposed dead metal parts which are liable to become energized and all dead metal parts within the enclosure which are exposed to contact during servicing and maintenance.

8. The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green, with or without one or more yellow stripes and no other leads visible to the installer, other than grounding conductors, shall be so identified.

9. A field-wiring terminal intended for connection of an equipmentgrounding conductor shall be plainly identified, such as being marked G, GR, Ground, Grounding, or the equivalent, or by a suitable marking on a wiring diagram provided on the detector. The field-wiring diagram is provided on the detector. The field- wiring terminal shall be so located that it is unlikely to be removed during normal servicing of the detector.

10. A field-wiring terminal for the connection of a grounded supply conductor shall be identified by means of a metallic plated coating substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

11. A field-wiring lead provided for connection of a grounded supply conductor shall be finished to show a white or natural gray color and shall be readily distinguishable from other leads and no other leads, other than grounded conductors, shall be so identified.

12. A terminal or lead identified for the connection of the grounded supply conductor shall not be electrically connected to a single-pole manual switching device which has an off position or to a single-pole overcurrent (not thermal) protective device.

(l) ***Field-wiring Compartment.***

1. The field-wiring compartment area of a detector to which connections are to be made is to be of sufficient size for completing all wiring connections as specified by the installation wiring diagram.

2. Protection for the internal components and wire insulation from sharp edges shall be provided by insulating or metal barriers having smoothly rounded edges or by the following or equivalent instructions located in the wiring area: "CAUTION-When making installation route field wiring away from sharp projections, corners and internal components."

3. The location of an outlet box or compartment in which field- wiring connections are to be made shall be such that these connections may be inspected after the detector is installed as intended.
The removal of not more than two mounting screws, or an equivalent arrangement, to view the field connections, is considered as meeting the intent of this paragraph.

(m) ***Internal Wiring.***

1. The internal wiring of a unit shall consist of conductors of at least the size required by the Basic Electrical Regulations, corresponding to the current rating of the unit, and having insulation rated for the potential involved and the temperatures to which it may be subjected. The wiring shall be routed away from moving parts and sharp projections and held in place with clamps, string ties or equivalent, unless of sufficient rigidity to retain a shaped form.

2. Leads or a cable assembly connected to parts mounted on a hinged cover shall be of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. The leads shall be secured or equivalently arranged to prevent abrasion of insulation and jamming between parts of the enclosure.

3. If the use of a short length of insulated conductor is not feasible, e.g., a short coil lead or the like, electrical insulating tubing may be employed. The tubing is not to be subjected to sharp bends, tension, compression, or repeated flexing, and is not to contact sharp edges, projections, or corners. The wall thickness of the tubing is to conform to the requirements for such tubing, except that the wall thickness at any point for polyvinyl chloride tubing of 3/8-inch diameter or less, is to be not less than 0.017 inch. For insulating tubing of other types, the wall thickness is to be not less than required to at least equal the mechanical strength, dielectric properties, heat and moisture resistant characteristics, etc. of polyvinyl chloride tubing having a wall thickness of 0.017 inch.

4. Internal wiring of circuits which operate at different potentials shall be reliably separated by barriers or shall be segregated, unless the conductors of the circuits of lower voltage are provided with insulation equivalent to that required for the highest voltage involved. Segregation of insulated conductors may be accomplished by clamping, routing or equivalent means which ensures permanent separation. See Item 10.

5. Stranded conductors clamped under wire-binding screws or similar parts shall have the individual strands soldered together or be equivalently arranged to ensure reliable connections.

6. Wireways shall be smooth and free from sharp edges, burrs, fins, moving parts, etc., which may cause abrasion of the conductor insulation.

7. All splices and connections shall be mechanically secured and bonded electrically.

8. A splice shall be provided with insulation equivalent to that of the wires involved if permanence of electrical spacing between the splice and uninsulated metal parts is not assured.

9. Splices shall be located, enclosed and supported so that they are not subject to damage from flexing, motion or vibration.

10. A metal barrier shall have a thickness at least equal to that required by Table 12-72-3B, based on the size of the barrier. A barrier of insulation material shall be not less than 0.028 inch in thickness and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose. Any clearance between the edge of a barrier and a compartment wall shall be not more than 1/16 inch.

11. Where a lead or wire harness passes through an opening in a wall, barrier, or enclosing case, there shall be a metal or insulating type bushing, or the equivalent, which shall be substantial, reliably secured in place, and shall have a smooth rounded surface against which the wire may bear.

12. If the opening is in a phenolic composition or other suitable nonconducting material or in metal of thickness greater than 0.042 inch, a smooth surface having rounded edges is considered to be the equivalent of a bushing.

13. Ceramic materials and some molded compositions are considered to be acceptable for insulating bushings, but separate buildings of wood and of hot-molded shellac are not acceptable.

14. Fiber may be employed where it will not be subjected to a temperature higher than 90? C (194? F) under normal operating conditions, the bushing is not less than 1/16 inch in thickness with a minus tolerance of 16/4 inch for manufacturing variations, and it is so formed and secured in place that it will not be affected adversely by ordinary ambient conditions of humidity.

15. If a soft-rubber bushing is employed in a hole in metal, the hole shall be free from sharp edges, burrs, projections, etc., which would be likely to cut into the rubber.

16. An insulating metal grommet may be considered acceptable in lieu of an insulating bushing, provided that the insulating material used is not less than 1/32 inch in thickness and fills completely the space between the grommet and the metal in which it is mounted.

17. A strain relief means shall be provided for the field supply leads, and all internally connected wires or cords which are subject to movement in conjunction with the installation, operation or normal servicing of a detector to prevent any mechanical stress from being transmitted to terminals and internal connections. Inward movement of the cord or leads provided with a ring-type strain relief means shall not damage internal connections or components, or result in a reduction of electrical spacings.

18. Each lead employed for field connections or an internal lead subjected to movement or handling during installation and normal servicing shall be capable of withstanding for one minute a pull of 10 pounds without any evidence of damage or of transmitting the stress to internal connections.

(n) ***Lampholders and Lamps.***

1. Lampholders and lamps shall be rated for the circuit in which they are employed when the detector is operated under any condition of normal service.

2. A lampholder employing a screw shell shall be so wired that the screw shell will be connected to an identified (grounded circuit) conductor.

3. If more than one screw shell-type lampholder is provided, the screw shells of all such lampholders shall be connected to the same conductor unless there is no shock hazard present (30 volts RMS or less) when replacing the lamps.

4. A lampholder shall be installed so that uninsulated live parts will not be exposed to contact by persons removing or replacing lamps in normal service.

(o) ***Operating Components.***

1. Operating components and assemblies, such as switches, relays, and similar devices, shall be adequately protected by individual protection or dust-tight cabinets, against fouling by dust or by other material which may affect their normal operation.

2. Moving parts shall have sufficient play at bearing surfaces to prevent binding.

3. Provision shall be made to prevent adjusting screws and similar adjustable parts from loosening under the conditions of actual use.

4. Manually operated parts shall have sufficient strength to withstand the stresses to which they will be subjected in operation.

5. An electromagnetic device shall ensure reliable and positive electrical and mechanical performance under all conditions of normal operation.

(p) ***Switches.***
1. A switch provided as part of a unit shall have a current and voltage rating not less than that of the circuit which it controls when the device is operated under any condition of normal service.

2. If a reset switch is provided, it shall be of a self-restoring type.

(q) ***Over-current Protection.*** *Fuseholders, fuses and circuit breakers provided on a detector unit shall be rated for the application.*

(r) ***Printed Wiring Boards.*** *Printed wiring boards shall be acceptable for the application. The securing of components to the board shall be made in a reliable manner and the spacings between circuits shall comply with the spacings requirements. The board shall be reliably mounted so that deflection of the board during servicing shall not result in damage to the board or in a fire or shock hazard. (See SFM 12-72-1.)*

(s) ***Service and Maintenance Protection.***

1. An uninsulated live part and hazardous moving parts within the enclosure shall be located, guarded or enclosed so as to minimize the likelihood of accidental contact by persons performing service functions which may have to be performed with the equipment energized.

2. Manual-switching devices may be located or oriented with respect to uninsulated live parts or hazardous moving parts so that manipulation of the mechanism can be accomplished in the normal direction of access if uninsulated live parts or hazardous moving parts are not located in front (in the direction of access) of the mechanism and are not located within 6 inches on any side or behind the mechanism, unless guarded.

3. In determining compliance with Item 2, only uninsulated live parts in high-voltage circuits are to be considered.

4. An electrical control component which may require examination, adjustment, servicing or maintenance while energized (excluding voltage measurements except for jacks or terminals specifically intended for that purpose) shall be located and mounted with respect to other components and with respect to grounded metal parts so that it is accessible for electrical service functions without subjecting persons to the likelihood of shock hazard from adjacent uninsulated live parts or to accident hazard from adjacent hazardous moving parts.

5. Other arrangements of location of components and/or guarding are also acceptable where electrical components are accessible for service as indicated by Item 4.

6. The following are not considered to be uninsulated live parts: (1) coils of controllers, relays and solenoids, and transformer windings, if the coils and windings are provided with suitable insulating overwraps, (2) enclosed motor windings, (3) terminals, and (4) splices with suitable insulation and insulated wire.

(t) ***Spacings.***

1. A detector shall provide reliably maintained spacings between uninsulated live parts and dead metal parts and between uninsulated live parts of opposite polarity. The spacings shall be not less than those indicated in Table 12-72-3E.

2. The spacing between an uninsulated live part and a wall or cover of a metal enclosure, a fitting for conduit or metal-clad cable, and any dead-metal part shall be not less than that indicated in Table 12-72-3E.

3. The through air and over surface spacings at an individual component part are to be judged on the basis of the volt-amperes used and controlled by the individual component. However, the spacing from one component to another, and from any component to the enclosure or to other uninsulated dead metal parts excluding the component mounting surface, shall be judged on the basis of the maximum voltage and total volt-ampere rating of all components in the enclosure.

4. The spacing requirements in Table 12-72-3E do not apply to the inherent spacings inside motors, except at wiring terminals, or to the inherent spacings of a component which is provided as part of the detector. Such spacings are judged on the basis of the requirements for the component. The electrical clearance resulting from the assembly of a component into the complete device, including clearances to dead metal or enclosures, shall be those indicated in Table 12-72-3E.
5. The "to walls of enclosure" spacings are not to be applied to an individual enclosure of a component part within an outer enclosure.

6. An insulating liner or barrier of vulcanized fiber, varnished cloth, mica, phenolic composition or similar material employed where spacings would otherwise be insufficient, shall be not less than 0.028 inch in thickness, except that a liner or barrier not less than 0.013 inch in thickness may be used in conjunction with an air spacing of not less than one-half of the through air spacing required. The liner shall be located so that it will not be affected adversely by arcing.

7. Insulating material having a thickness less than that specified in Item 6 may be used, if upon investigation, it is found to be adequate for the particular application.

8. Enamel-insulated wire is considered to be a bare current- carrying part in determining compliance of a device with the spacing requirements, but enamel is acceptable as turn-to-turn insulation in coils.

Performance Sec. 12-72-303.

(a) ***General.***

1. Unless otherwise specified, detectors representative of production are to be used for each of the following tests.

2. The devices employed for testing are to be those specified by the wiring diagram of the detector, except that substitute devices may be used if they produce functions and load conditions equivalent to those obtained with the devices intended to be used with the detector in service.

3. Data on detector components, e.g., capacitors, resistors (other than carbon or wire wound), solid state devices, etc., shall be provided by the manufacturer for evaluation of the reliability of the components for the intended application. If a Mil-Spec. is referenced, a copy of the specification is to be provided for review. A failure rate of 0.5 failure per million hours for nonsupervised components would be acceptable.

4. The data required in the preceding paragraph shall include the following:
A. ***Component fault analysis.*** *Effect of failure, open and short, particularly of capacitors, on operation of a detector.*

B. A description of any component screening and burn-in test, if available.

C. Amount of derating of components under normal standby and alarm conditions. A derating of 50 percent or more is acceptable for all components except for electrolytic capacitors. See also Table 12-72-3F.

D. ***Component failure rate data at rated values and derated values.*** *This may be in the form of a reference to a Mil-Spec. handbook or equivalent.*

E. Maximum ratings for components.

F. Any other data, not included above, which will provide an equivalent reliability analysis.

5. Unless specifically specified otherwise, the test voltage for each test of a detector shall be as follows at rated frequency:

DETECTOR RATED VOLTAGE, NAMEPLATE	***TEST VOLTAGE***
110 to 120	*120*
220 to 240	*240*
Other	*Marked Rating*

6. The following samples are used to perform the tests of this standard:

A. At least 20 assembled detectors fully representative of production units.
B. One additional unassembled detector fully representative of production units.

C. Five additional samples of detectors employing a radioactive source. These may be partial assemblies illustrating the radioactive source installation.

D. Three control units and/or power supplies if the detectors are intended specifically to be employed with a specific unit or power supply.

E. The monitoring instrument or reference to a commonly available meter intended to monitor sensitivity of a detector.

(b) ***Normal Operation.***

1. A detector shall be capable of operating for all conditions of its intended performance at all sensitivity settings when employed in conjunction with any related power supply or control unit with which it is intended to be employed and indicating devices to form the system combination covered by the installation wiring diagram and any supplementary information provided.

2. The test voltage shall be in accordance with Section 12-72-303 (a), Item 5, and the combustion products detector shall be in the normal circuit supervisory standby condition and prepared for normal signaling operation when it is connected to related devices and circuits.

3. The introduction of combustion products into the detector chamber such as produced by a smoldering cotton lamp wick, rope or equivalent, shall result in the operation of the detector in its intended manner. Section 12-72-303 (p), Item 2.

(c) ***Power Input and Output.*** *The input or output current of each circuit of a combustion products detector shall not exceed the marked rating by more than 10 percent when the detector is operated under the conditions of normal use and with the detector connected to a source of supply in accordance with Section 12-72-303 (a), Item 5.*

(d) ***Electrical Supervision.***

1. All nonreliable components such as electronic tube heaters, blower motors, capacitors, functional heating elements, etc., the failure of which may result in an open or shorted condition shall be electrically supervised. See Sections 12-72-302 (e); 12-72-303 (a), Item 3; 12-72-303 (e) and 12-72-303 (s).

2. All electrical circuits formed by conductors extending from the installation wiring connections for interconnecting to a power supply or system control units the failure of which may result in an open or ground fault shall be electrically supervised either at the detector or at the control unit to which a detector would be connected. See Section 12-72-302 (e).

3. The requirements of Sections 12-72-392 (d), Items 1 and 2, do not apply to the following:

A. Trouble indicating circuits.

B. The circuits of a detector employed only for releasing device service if the fault results in the same operation of the unit as that obtained by detection of combustion products.

C. A circuit for a supplementary signal annunciator, signal sounding appliance, motor controller, or similar appliance provided that a break or a ground fault in no way affects the normal operation of the unit except for omission of the supplementary feature.

(e) ***Electrical Supervision Test.***

1. The electrical circuits formed by conductors extending from the installation wiring connections of a detector for interconnection to a power supply source or system control unit initiating device circuit shall be electrically supervised

so that the detector trouble signal or circuit is energized under any of the following fault conditions if the fault prevents normal operation of the detector for fire alarm signals.

A. Single open or single ground fault of the connecting field wiring.

B. Failure of a nonreliable component. See Sections 12-72-303 (d), Item 1; 12-72-303 (a), Item 3; and 12-72-303 (s).

2. A motor included in a detector, such as a blower motor which is required to operate continuously during normal operation, shall be supervised to indicate stalling or burnout.

3. The heaters of all electronic tubes or other functional heating elements employed in a detector shall be electrically supervised to indicate an open circuit fault by an audible trouble signal if the fault prevents normal operation of the unit.

4. Internal shorts between any two elements of an electronic tube shall be indicated by either a trouble signal or an alarm signal if such failure prevents normal operation of the unit. Such a failure shall not result in a fire hazard.

5. Interruption and restoration of any source of electrical power connected to a detector unit shall not cause an alarm signal.

6. The operation of any manual switching part of a detector unit to other than its normal position while the detector unit is in the normal standby condition shall be indicated by a trouble signal, if the off-normal position of the switch interferes with normal operation of the detector unit.

7. To determine if a detector unit complies with the requirements for electrical supervision, see Section 12-72-303 (d). The detector is to be tested with the representative system combination in its normal supervisory condition, and the type of fault to be detected is then to be introduced. Each fault shall be applied separately, the results noted and the fault removed. The system combination is then to be restored to its normal supervisory condition prior to establishing the next fault.

(f) ***Sensitivity Test.***

1. A combustion products detector shall operate within the limits specified below when subjected to a smoldering smoke condition using the combustion products and test equipment described in the following paragraphs. If the detector employs a variable sensitivity setting, test measurements are to be made at maximum, minimum and nominal settings.

A. Visible Smoke Obscuration Limits- 0.0 percent per foot maximum (0.013)1 0.2 percent per foot minimum (0.001)1 B. Relative Combustion Products Measurement Limits- 9.0 volts maximum 1.0 volt minimum C. Monitoring Means- Within 25 percent of the operating limits of the detector rating.

2. ***Combustion products.*** *A mercerized cotton lamp wick, nominally 7/8 inch wide by 1/8 inch in cross section and secured by an alligator type clip 3 inches below a removable cover assembly is to be employed as the source of combustion products. The wick end is to be cut square and smoldering initiated by momentarily placing the wick end over a horizontally mounted resistive heater element energized to a dull red color. Smoldering may be promoted by passing a slow current of air over the wick end. The smoldering end is to be cut away approximately 1/4 inch above the charred section prior to conducting a succeeding trial. The smoldering rate of the wick is to be such that the visible smoke obscuration increases at an approximate uniform rate of 1.5 ?0.2 percent per foot (0.0329 0.001 optical density per foot).*

(g) ***Test Equipment and Methods.***

1. The visible smoke obscuration (optical density) in the test compartment is to be measured by means of a direct current (DC) type microammeter having a maximum internal resistance of 100 ohms used with a barrier type selenium photovoltaic cell, enclosed in a hermetically sealed case.2 The meter and cell are used in conjunction with the light produced by a tungsten filament automotive type lamp rated 6 volts and energized from a regulated supply to provide a light beam of uniform flux density. The photoelectric cell and lamp are to be spaced 5 feet apart. The following equations are to be used:

A. At any distance, the percent obscuration per foot will be:
Ou = [1 - (Ts/Tc)1/d) 100
WHERE:
Ou = Percent obscuration per foot.
Ts = Smoke density meter reading with smoke.
Tc = Smoke density meter reading with clear air.

d = Distance in feet (m 3.33).

B. The percent obscuration of light for the full length beam at any distance will be:
Od = [1 - (Ts/Tc)] 100
WHERE:
Od = Percent obscuration at distance d.
Ts = Smoke density meter reading with smoke.
Tc = Smoke density meter reading with clear air.

C. When the percent obscuration per foot is known, the percent obscuration for the full length of any longer beam can be determined by the following:
Od = [1 - [1 - (Ou/100)]d] 100
WHERE:
Od = Percent obscuration at distance d.
Ou = Percent obscuration per foot.
d = Distance in feet (m 3.33).

D. At any distance, the total optical density will be:
ODt = Logo10 (Tc/Ts)
WHERE:
ODt = Optical density.
Tc = Smoke density meter reading with clear air.
Ts = Smoke density meter reading with smoke.

E. At any distance, the optical density per foot will be:
ODf = [Log10 (Tc/Ts)]/d
WHERE:
ODf = Optical density per foot.
Tc = Smoke density meter reading with clear air.
Ts = Smoke density meter reading with smoke.
d = Distance in feet (m 3.33).

2. A meter3 calibrated in volts is to be used to measure the relative buildup of primarily invisible products of combustion. The meter, used with an ionization detecting monitoring head without an alarm indicating circuit, has Americium 241 as the radioactive element. The monitoring head is to be located in the test chamber adjacent to the sample under test.

3. ***Test chamber.*** *The following items refer to Figure 12-72-3-1.*

A. ***Cabinet.*** *Plywood, 3/4 inch thick, except for 1/4 inch thick clear plastic front panel. Overall dimensions approximately 691/2 inches long, 18 inches high, 11 inches deep. A center divider forms two equal 8 inches high by 10 inches deep interior compartments. Inside of lower left side of plastic front panel, as well as all interior surfaces of the cabinet are to be painted flat black. Plastic front assembled with rubber gasket.*

B. ***Combustible.*** *Cotton wick. See Section 12-72-303 (f), Item 2. Secured by alligator type clip to removable cap which covers a 31/4-inch diameter hole in top of compartment. Cap measures approximately 4 inches square. Center of hole located approximately 16 inches from left end.*

Footnote:
1Figure in parentheses denotes optical density per foot.
2A meter suitable for this purpose is Weston Instrument Model 622 in conjunction with a Model 594 RR Photronic Cell.
3A meter suitable for this purpose is a Pyrotronics, Inc., Type CPM-2 with monitoring head

C. ***Air dispersing medium.*** *Three-fourths inch nominal diameter solid glass beads to fill to capacity an expanded metal container, approximately 4 inches wide, 8 inches high, 10 inches deep.*
Any space between top surface of beads and compartment ceiling to be filled with foam plastic. Provides uniform flow of air and combustion products. Center of unit approximately 22 inches from right-hand side of compartment.

D. ***Air circulating fan.*** *Motor mounted on 1/4 inch plastic support which fits into slots of compartment and fills completely the upper chamber. Employs 5 inch (100 cfm) diameter fan.*

E. ***Opening.*** *Rectangular hole, approximately 6 by 4 inches, center of opening 4 inches from end of cabinet.*

*F. **Exhaust fan.** Same as Item D. Mounted in end wall of compartment.*

*G. **Exhaust fan cover.** Plastic, approximately 53/4 inches wide, 10 inches long, by 3/16 inch thick. Fitted in slots.*

*H. **Lamp.** Low voltage automobile-type lamp. See Section 12-72-303 (g), Item 1.*

*I. **Monitoring head.** Ionization detector mounted on back wall in test area. See Section 12-72-303 (g), Item*

2. Employed with Item M.

*J. **Photovoltaic cell.** See Section 12-72-303 (g), Item 1.*
Mounted on Item K. Has a linear response up to 800 microamperes at 200 footcandles.

*K. **Air dispersing medium.** Same as Item C, except 3 inches wide.*

*L. **Opening.** Rectangular, approximately 6 by 2 inches, center of opening 3 inches from left end. Covered with perforated metal having approximately 50 percent openings.*

*M. **Combustion products meter.** See Section 12-72-303 (g), Item 2. Meter is to have a 0-10 volts scale. Employed with ionization head (Item I). Provides indication of relative build-up of combustion products in test chamber.*

*N. **Control equipment.** Includes fan and switch controls, lamp voltage control and terminals for connection of microammeter.*

*O. **Obscuration equipment meter.** See Section 12-72-303 (g), Item 1. Meter is to have 0-100 or 0-200 microamperes full scale.*

*P. **Access door for test sample.** Plastic, approximately 111/2 by 71/2 by 1/4 inch thick. Secured by hinges and spring catch to front section. Center of door approximately 30 inches from right- hand side of cabinet. Fitted with rubber gasket to prevent air loss.*

*4. **Test method.** The test is to be conducted in an ambient temperature of 23 ?3? C (73.4 ?5? F) at a relative humidity between 30-50 percent and a barometric pressure of not less than 700 millimeters of mercury. A minimum of 12 samples of the detector, previously energized for at least 16 hours or as recommended by the manufacturer from a source of supply in accordance with Section 12-72-303 (a), Item 5, are to be subjected to this test. The samples shall be momentarily disconnected from the source of supply, placed in the center of the lower section of the test chamber with the signaling contacts connected to an indicating circuit and re- energized from the specified source of supply.*

5. With the air velocity in the test compartment maintained at 30-35 feet per minute (fpm), as measured in the sample area, the wick is to be inserted into the upper chamber with the smoldering end facing downward. The air flow is to be parallel to the 1/8 inch thick end of the wick and the wick end is to be approximately 3 inches below the compartment roof. See Section 12-72-303 (r), Item 2. Operation is to be continued until the detector is actuated in an alarm condition. Five test trials shall be conducted on each sample with at least a five-minute interval between each trial. The following readings are to be recorded for each trial at the moment of actuation: (1) visible smoke obscuration, (2) combustion products meter reading, (3) elapsed time of test trial, and (4) the monitoring means. If a detector has a variable sensitivity setting, five trials are to be made at the maximum, minimum and nominal sensitivity settings.

6. The detector shall be uniform in operation so that the average of the readings of the smoke density and combustion products meters of the mean three of five trials (highest and lowest not included) of one detector shall be within 50 percent of the mean average of all detectors. If a detector has a variable sensitivity setting, the requirement applies to each setting tested.

7. There shall be no false alarms or effect on operation of a detector set at the maximum sensitivity setting when two representative samples are subjected to the following test conditions:

A. Operation for three months in an ambient room temperature of approximately 25 ?? C (77 ?5? F) and relative humidity of 30-50 percent, having a relatively clean atmosphere with minimum air movement.

B. Operation for three months in a relatively clean atmosphere in laminal air stream having a velocity of 300 ?25 fpm. in an ambient room temperature of approximately 25 ?3 ? C (77 ?5? F) and relative humidity of 30-50 percent.

C. Ten cycles of humidity variation between 20 and 90 ?5 percent at room temperature.

D. Ten cycles of temperature variation between 17.8? C and 66? C (0? F and 150? F).

E. Ten cycles of rapid change of air velocity from 0 to 300 ?25 fpm.

F. Ten cycles of a 2-inch drop of air pressure starting from 29-31 ?0.5 inch of mercury.

G. Fifty cycles of momentary interruption of the detector power supply at a rate of not more than 6 cycles per minute.

8. Two detectors, employing a maximum sensitivity setting are to be mounted in a position of normal use, energized from a source of supply in accordance with Section 12-72-303 (a), Item 5, and subjected to each of the above test conditions.

9. For tests, C, D and F of Section 12-72-303 (g), Item 5, the time of cycling from one extreme to the other shall be a maximum of one hour and a minimum of five minutes. For test E the air velocity is to be turned on and off abruptly with a maximum of one hour between applications. For test F the time of change from one pressure to the other is approximately one-half minute. The cycling is conducted at a rate not faster than once per 10 seconds. Each cycle is to start at one test condition, changing to the other extreme, and returning to the original test condition.

10. The test samples subjected to tests A-G of Section 12-72-303 (g), Item 5, are to be tested for sensitivity, see Sections 12-72-303 (f) following the completion of the test. The response of the detectors, when tested in accordance with the sensitivity test, shall not vary more than 50 percent from the value obtained prior to the test.

(h) ***Deleted.***

(i) ***Fire Test.***

1. At least two of the four detectors subjected to each of the following combustible tests shall operate for alarm when installed on 30-foot spacings and exposed to the following four types of controlled test fires. The maximum response time shall be two minutes for tests A, B and C, and four minutes for test D.

A. ***Paper.*** *Combustible is to be 1/2 pound of shredded newsprint type paper, strips to be 1/4 to 3/8 inch wide, 6 to 24 inches long placed in a receptacle formed of 1/4 inch mesh hardware cloth. The receptacle is to be approximately 12 inches in diameter by 24 inches high with a hardware cloth bottom 6 inches above the base. The combustible is to be ignited at the bottom center. Paper is to be dried prior to test.*

B. ***Polystyrene.*** *Combustible is to be 2 ounces of typical foam polystyrene type packing material, with no flame inhibitor, each piece 1/4 to 3/8 inch diameter, 3 to 10 inches long placed in the same type of receptacle as used for test A. Alternate shape of combustible is cylindrical, 3/4 inch diameter by 1/2 inch high having a 3/8-inch diameter hole. The combustible is to be ignited at the bottom center.*

C. ***Gasoline.*** *Combustible is to be 200 cubic centimeters (cc) of regular leaded gasoline placed in a 9-inch diameter steel pan container 11/2 inches deep.*

D. ***Wood brand (Class A).*** *Combustible is to be three layers of kiln dried fir strips, each strip 3/4 inch in cross section, 12 inches long with 12 strips in each layer. Strips are to be nailed or stapled together with adjacent layers at right angles to each other. Overall dimensions of wood brand is approximately 12 by 12 by 21/4 inches high. The brand is to be ignited by burning 100 cc of denatured alcohol consisting of 190 proof (95 percent) ethanol to which 5 percent methanol is added as a denaturant. The alcohol is placed in the same type of container as used for test C.*

2. The fire tests are to be conducted in a room having a smooth ceiling with no physical obstructions between the fire source and detectors and with minimum air movement. The room is to be provided with means for the removal of combustion products, such as vents or exhaust fans. Heaters are to be provided for maintaining the room temperature ambient, if necessary. The heaters are to be shut off during a test trial. The room shall be of sufficient cross- sectional area so that the detectors can be located in accordance with the spacing layout illustrated by Figure 12-72-3-2 and any reflection of combustion products is prevented from returning to the detectors from adjacent walls during the course of the test. The room height shall be such that the vertical distance from the base of the combustible to the ceiling is approximately 12 feet.

3. The tests are to be conducted in an ambient temperature between 15.6? C and 26.7? C (60? F and 80? F) and a relative humidity of 50 ?20 percent. The test samples are to be energized from a source of supply in accordance with Section 12-72-303 (a), Item 5.

4. Four samples, each adjusted to their minimum sensitivity setting, are to be installed on the ceiling at a 30-foot spacing schedule with relation to the test fire (21.2-foot linear distance measured along the ceiling to a point directly over the center of the test fire). See Figure 12-72-3-2. The time starts at the moment of ignition. At least two trials shall be conducted for each combustible. Each detector shall respond at least once to each of the four combustibles employed.

5. Sensitivity monitoring instruments are to be employed to determine that the test room area is free of products of combustion prior to conducting a test.

(j) ***Temperature Test.***

1. The materials or components employed in a detector shall not be affected adversely by the temperatures attained under any condition of normal operation.

2. A material or component will be considered as being adversely affected if it is subject to a temperature rise greater than that indicated in Table 12-72-3F.

3. The classes of material used for electrical insulation referred to in Items 8 and 9 of Table 12-72-3F include the following:

Class A - Impregnated cotton, paper, and similar (Class 105) organic materials when impregnated, and enamel as applied to coil windings.

Class B - Inorganic materials, such as mica and (Class 130) impregnated asbestos.

4. All values for temperature rises apply to equipment intended for use in ambient temperatures normally prevailing which usually are not higher than 25? C (77? F). If equipment is intended specifically for use with a prevailing ambient temperature constantly more than 25? C (77? F), the test of the equipment is made at the higher ambient temperature, and the allowable temperature rises specified in the table are to be reduced by the amount of the difference between that higher ambient temperature and 25? C (77? F).

5. Temperature measurements on equipment intended for recessed mounting shall be made with the unit installed in an enclosure of nominal 3/4 inch wood having clearances of 2 inches on the top, sides and rear, and the front extended to be flush with the detector cover.

6. A temperature is considered to be constant when three successive readings, taken at not less than five minute intervals, indicate no change.

7. Temperatures are to be measured by means of thermocouples consisting of wires not larger than No. 24 AWG. The preferred method of measuring the temperature of a coil is the thermocouple method, but a temperature measurement by either the thermocouple or resistance method is acceptable, except that the thermocouple method is not to be employed for a temperature measurement at any point where supplementary thermal insulation is employed.

8. If thermocouples are used in the determination of temperatures, it is standard practice to employ thermocouples consisting of No. 24-30 AWG iron and constantan wires and a potentiometer type indicating instrument. Such equipment will be used whenever referee temperature measurements by thermocouples are necessary.

9. The thermocouple wire is to conform with the requirements for "special" thermocouples as listed in the Table of Limits of Error of Thermocouples in ANSI C96.1-1964 (R1969).

10. The temperature of a copper coil winding is determined by the resistance method by comparing the resistance of the winding at the temperature to be determined with the resistance at a known temperature by means of the equation:
TE (R/r) (234.5 + t) - 234.5
WHERE:
T = is the temperature to be determined in degrees C.
t = is the known temperature in degrees C.
R = is the resistance in ohms at the temperature to be determined.
r = is the resistance in ohms at the known temperature.

11. As it is generally necessary to de-energize the winding before measuring R, the value of R at shutdown may be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after the instant of shutdown. A curve of the resistance values and the time may be plotted and extrapolated to give the value of R at shutdown.

12. To determine compliance with this test, a detector is to be connected to a source of supply in accordance with Section 12-72-303 (a), Item 5, and operated under the following conditions:

A. ***Normal standby****-(16 hours) constant temperatures.*

B ***Alarm****-(1 hour).*

C. ***Alarm****- (7 hours) abnormal test.*

13. For test condition C the temperature limits may be exceeded but there shall be no manifestation of a fire hazard or approaching failure and the detector shall operate in a normal manner following the test.

14. The detector is to be subjected to the Dielectric Withstand Test following the above test.

(k) ***Over-and-under Voltage Operation.***

1. A detector shall withstand the continuous application of 110 percent of the test voltage specified by Section 12-72-303 (a), Item 5, in the normal standby condition at maximum and minimum sensitivity settings without being affected adversely and shall operate successfully for normal signaling performance at the specified increased voltage. Sensitivity measurements at the increased voltage shall be within 50 percent from the readings measured at rated voltage.

2. For operation at the higher voltage four new detectors are to be subjected to the specified increased voltage in the normal standby condition for at least 16 hours and then tested for normal signaling operation and sensitivity.

3. A detector shall operate for its normal signaling performance while energized from a supply of 85 percent of the test voltage specified by Section 12-72-303 (a), Item 5, for both maximum and minimum sensitivity settings. Sensitivity measurements at the reduced voltage shall be at 50 percent of the readings measured at rated voltage.

4. For operation at the reduced voltage four new detectors are to be energized from a source of supply in accordance with Section 12-72-303 (a), Item 5, following which the voltage is to be reduced to 85 percent of nameplate rating and then tested for normal signaling operation and sensitivity.

(l) ***Variable Ambient Temperature.***

1. A detector shall be capable of operating in a normal manner when tested in an ambient temperature of 0? C and 49? C (32? F and 120? F), at a relative humidity between 30-50 percent.

2. Two detectors are to be maintained at each ambient temperature for a sufficient length of time to ensure that thermal equilibrium has been reached. The units are then to be tested for sensitivity while connected to a source of supply in accordance with Section 12-72-303 (a), Item 5.

3. Sensitivity measurements shall be recorded before and during exposure to each ambient temperature in accordance with the sensitivity test.

4. Each unit shall operate normally in each ambient. The sensitivity readings measured with the units in each ambient temperature shall be within 50 percent of the value recorded in the normal ambient condition.

(m) ***Overload.***

1. A detector shall be capable of operating in a normal manner after being subjected to 50 cycles of alarm signal operation at a rate of not more than six cycles per minute with the supply circuit to the detector at 115 percent of rated nameplate voltage. Each cycle shall consist of starting with the detector energized in the normal standby condition, initiation of an alarm by smoke or electrical means, and restoration of the detector to normal standby condition.

2. Rated test loads are to be connected to those output circuits of the detector which are energized from the detector power supply, such as remote indicators, relays, etc. The test loads shall be those devices, or the equivalent, normally intended for connection. If an equivalent load is employed for a device consisting of an inductive load, a power factor of 60 percent is to be employed. The rated loads are established initially with the detector connected to a source of supply in accordance with Section 12-72-303 (a), Item 5, following which the voltage is increased to 115 percent of rating.

3. For direct current signaling circuits an equivalent inductive test load is to have the required direct current resistance for the test current and the inductance (calibrated) to obtain a power factor of 60 percent when connected to a 60 Hertz (Hz) alternating current potential equal to the rated direct current test voltage. When the inductive load has both the required direct current resistance and the required inductance, the current measured with the load connected to an alternating current circuit will be equal to 0.6 times the current measured with the load connected to a direct current circuit when the voltage of each circuit is the same.

4. Separately energized circuits of a detector such as dry contacts shall be capable of operating in a normal manner after being subjected for 50 cycles of signal operation at a rate of not more than six cycles per minute while connected to a source of supply in accordance with Section 12-72-303 (a), Item 5, with 150 percent rated loads at 60 percent power factor applied to output circuits which do not receive energy from the detector. There shall be no electrical or mechanical failure of the switching circuit.

5. The test loads shall be set at 150 percent of rated current while connected to a separate power source of supply in accordance with Section 12-72-303 (a), Item 5.

(n) ***Endurance.***

1. A detector shall be capable of operating in a normal manner after being subjected to 6,000 cycles of alarm signal operation at a rate of not more than 10 cycles per minute with the detector connected to a source of supply in accordance with Section 12-72-303 (a), Item 5, and with related devices or equivalent loads connected to the output circuits. There shall be no electrical or mechanical failure or evidence of failure of the detector components. The same detector shall be tested that had been subjected previously to the overload test.

2. Separately energized circuits of a detector shall be capable of performing acceptably when operated for 6,000 cycles at a rate of not more than 10 cycles per minute. When an electrical load is involved, the contacts of the device shall be caused to make and break the normal current at the voltage specified by Section 12-72-303 (a), Item 5. The load shall represent that which the device is intended to control. The endurance tests of the separately energized circuits may be conducted in conjunction with the endurance test of the detector. There shall be no electrical or mechanical failure of the detector nor undue pitting, burning or welding of any relay contacts.

(o) ***Dielectric Tests.***

1. A detector shall be capable of withstanding, without breakdown for a period of one minute, the application of a 60 Hz alternating potential between high-voltage, live parts and dead-metal parts, and between live parts of high- and low-voltage circuits, except as noted in Item 2. The test potential shall be:

A. 1,000 volts RMS plus twice rated voltage for high-voltage circuits.

2. A detector employing a low-voltage circuit shall be capable of withstanding, for one minute without breakdown, a 60 Hz alternating potential of 500 volts RMS applied between low-voltage live parts and dead-metal parts.

3. Any reference grounds shall be disconnected prior to the test applications.

4. A transformer, the output voltage of which is essentially sinusoidal, can be varied and can maintain the specified high potential voltage at the equipment during the duration of the test and is to be used to determine compliance with the foregoing. The applied potential is to be increased gradually from zero until the required test value is reached and is to be held at that value for one minute.

(p) ***Abnormal Operation.***

1. A detector shall be capable of operating continuously under abnormal conditions without resulting in a fire hazard.

2. To determine if a detector complies with the requirement of Item 1, it is to be operated under the most severe abnormal conditions liable to be encountered in service while connected to a source of supply in accordance with Section 12-72-303 (a), Item 5.
Emission of flame or molten metal, or any other manifestation of a fire hazard, is considered to be a failure.

3. In determining if a detector complies with the requirement with respect to circuit-fault conditions, the fault condition is to be maintained continuously until constant temperatures are attained, or until burnout occurs, if the fault does not result in the operation of an overload protective device. Shorting of electrolytic capacitors would represent a typical fault.

(q) ***Transient Tests.***

1. Two detectors shall be capable of operating in a normal manner after being subjected to 500 externally induced and 500 internally induced transients while energized from a source of supply in accordance with Section 12-72-303 (a), Item 5, and connected to the devices normally used with the unit.

2. The primary of a 120/240 volt, 60 Hz, 2 kilovolt-amperes (kVA) isolating power transformer, with the secondary open circuited, is to be connected to the same branch circuit as the detector.

The input to the transformer is to be de-energized for approximately one second by an automatic switching device at a rate of not more than six cycles per minute for 500 cycles. During the test the detector is to be operated for normal signaling performance to determine whether transients, generated by the random collapse of the magnetic field of the transformer, resulted in a component failure or other adverse effect.

3. The electrical characteristics of the testing transformer are as follows:

	Voltage	Frequency	Inductance (L) Millihenries	Quality Factor	DC Resistance (R) Ohms (23 C)
Primary winding	120	1,000	21.2	11.50	.244
Secondary winding	240	1,000	109.3	4.65	0.371

4. Two detectors are to be energized in the normal standby condition while connected to a source of supply in accordance with Section 12-72-303 (a), Item 5, which is to be interrupted for approximately one second at a rate of not more than six cycles per minute for a total of 500 cycles. Following the test the detector is operated for normal signaling performance.

(r) ***Humidity Test.***

1. Two detectors shall be capable of operating in a normal manner while energized from a source of supply in accordance with Section 12-72-303 (a), Item 5, after having been exposed for 24 hours to moist air having a relative humidity of 85 ?5 percent at a temperature of 30 ?2? C (86 ?3? F). The sensitivity shall be determined with the detector connected to a source of supply in accordance with Section 12-72-303 (a), Item 5.

2. Sensitivity measurements shall be recorded before and during exposure to the humidity condition in accordance with the sensitivity test.

3. The sensitivity values measured with the unit in the humid atmosphere shall be within 50 percent of the value recorded in the normal ambient condition.

(s) ***Component Failure.***

1. Failure of electronic components of questionable reliability such as opening or shorting of electrolytic capacitors shall either have no adverse effect on normal operation or may be indicated by a trouble or an alarm signal.

2. If failure of a questionable component cannot be indicated by a trouble or alarm signal, a reliable component shall be employed. The reliability may be based on derating or on reliability data recorded for the particular component. See Section 12-72-303 (a).

(t) ***Dust Test.***

1. The sensitivity of a detector shall either not be affected adversely by an accumulation of dust or may result in a false alarm.

2. To determine compliance with Item 1 two samples in their normal mounting position, are to be placed, de-energized, in an air tight chamber having an internal volume of at least 3 cubic feet.

3. Approximately 2 ounces of cement dust, capable of passing through a 200 mesh screen, is to be circulated for 15 minutes by compressed air or a blower under controlled velocity conditions not exceeding 50 rpm so as to completely envelop the sample in the chamber.

4. Following the exposure to dust the detector is to be removed carefully, mounted in its intended position, energized from a source of supply in accordance with Section 12-72-303 (a), Item 5, and tested for sensitivity unless a false alarm is obtained. Sensitivity measurements after subjection to the dust test may be greater than 50 percent toward the more sensitive region but shall not be more than 50 percent toward the insensitive region.

(u) ***Static Discharge Test.***

1. The components of a detector shall be shielded so that its operation is not affected adversely, or a false alarm obtained, when subjected to static electric discharges. Operation of the trouble circuit during this test is not considered a failure.

2. Each of two detectors is to be mounted in its intended mounting position and connected to a source of supply in accordance with Section 12-72-303 (a), Item 5. A 250 picofarad low leakage capacitor rated 10,000 volts direct current, is to be connected to two high-voltage insulated leads, 3 feet long, stripped 1 inch at each end. The end of each lead is to be attached to a metal test probe mounted on a plastic insulating rod to permit manipulation and isolation from shock hazard. The test probes shall be metallic rods with a spherical end of 1/4 inch radius. The capacitors are to be charged by touching the ends of the test leads to a source of 10,000 volts direct current for at least two seconds for each discharge.

3. Ten discharges with at least a five minute interval between discharges are to be applied to different points on the exposed surface of the detector, recharging the capacitors for each discharge.
Five discharges are to be made with one probe connected to earth ground and the other probed on the detector surface followed by five discharges with the polarity reversed.

4. Following the discharges, if a trouble or an alarm signal is not obtained, the detector is to be tested for sensitivity. Sensitivity measurements shall be within 25 percent of the average of the readings measured prior to the test.

(v) ***Vibration Test.***

1. A detector shall be capable of withstanding vibration without breakage or damage to parts. Following the vibration the detector shall be capable of operating in a normal manner.

2. To determine compliance with Item 1, sensitivity measurements following the vibration shall be conducted in accordance with the sensitivity test and shall be within 50 percent of the value recorded in the normal ambient condition.

3. Two samples, one at the maximum and one at the minimum sensitivity setting, are to be secured in their intended mounting position on a mounting board and the board, in turn, securely fastened to a variable speed vibration machine having an amplitude of 0.01 inch. The frequency of vibration is to be varied from 10 to 35 cycles per second in increments of five cycles per second until a resonant frequency is obtained. The samples are then to be vibrated at the maximum resonant frequency for a period of one- fourth hour. If no resonant frequency is obtained, the samples are to be vibrated at 35 cycles per second for a period of four hours.

4. For these tests, amplitude is defined as the maximum displacement of sinusoidal motion from a position of rest or one-half of the total table displacement. Resonance is defined as the maximum magnification of the applied vibration.

(w) ***Jarring Test.***

1. A detector shall be capable of withstanding jarring resulting from impact and vibration such as might be experienced in service, without affecting adversely its subsequent normal operation.
A trouble signal resulting from the jarring may be permitted if the normal operation is not affected.

2. The detector and associated equipment, if any, are to be mounted in a position of intended use to the center of a 6 by 4 foot nominal 3/4-inch thick plywood board which is secured in place at four corners. A 3-foot board impact is to be applied to the center of the reverse side of this board by means of a 1.18 pound, 2 inch diameter steel sphere either (1) swung through a pendulum arc from a sufficient height, (h) of 2.54 feet or (2) dropped from a sufficient height (h) of 2.54 feet to apply 3 foot-pounds of energy depending upon the mounting of the equipment. See Figure 12-72-3-3.

3. Compliance with Item 1 is to be determined by supporting the detector in its intended mounting position and conducting the jarring while the unit is in the normal standby condition and connected to a rated source of supply in accordance with Section 12-72-303 (a), Item 5. Following the jarring the unit(s) shall be tested for sensitivity. Sensitivity measurements following the jarring shall be within 25 percent of the average of the readings measured prior to the test.

(x) ***Corrosion Test.***

1. A detector shall be capable of operating in a normal manner after being subjected to the corrosive atmosphere tests described in the following paragraphs.

2. Two samples, one at maximum and one at minimum sensitivity setting, are to be exposed to an atmosphere containing approximately 1 percent hydrogen sulphide by volume in air saturated with water vapor at room temperature for 10 days. The units are not energized during the exposure.

3. Two samples, one at maximum and one at minimum sensitivity settings are to be exposed to an atmosphere containing approximately 1 percent carbon dioxide and 0.5 percent sulfur dioxide by volume in air saturated with water vapor at room temperature for 10 days.

4. The detectors are to be tested for sensitivity prior to exposure to the corrosive atmospheres. Twenty-four hours or more after the required exposure the detectors are to be again tested for sensitivty. Sensitivity measurements following the exposure to the corrosive atmospheres shall be within 50 percent of the value recorded in the sensitivity test, except as indicated in Item 5.

5. The sensitivity following exposure to the corrosion atmospheres described in Item 3 may exceed 50 percent from the value measured prior to the corrosion exposure if the same units, set at their minimum sensitivity, are subjected to and comply with the fire test requirements described in Section 12-72-303 (i), Items 1-5.

(y) ***Radioactive Element Measurement Test.***

1. The total activity of the radioactive source(s) of a detector shall not exceed the maximum content specified in the marking on the detector by more than 10 percent.

2. The measurement shall be made on at least five samples of the detector in the as-received condition using appropriate instrumentation and techniques.

(z) ***Paint Loading Test.***

1. A detector shall operate in a normal manner and shall comply with the requirements of the sensitivity test after painting, if the detector assembly, screens, openings, etc. are likely to be clogged by painting. If a detector is marked prominently so it will be visible after the unit is installed which prohibits painting, then this test need not be conducted. See Section 12-72-303 (a) and (b).

2. The exterior surfaces of two samples, including screened openings, etc., are to be coated with a lead-oil base paint which is spread at approximately two times the paint manufacturer's recommended spreading rate. The paint is to be allowed to dry, for five days at room temperature. Following this, the samples are to be given a second identical application of paint and again permitted to dry for five days. The detectors are to be tested for sensitivity, one at maximum and one at minimum sensitivity setting before and after the specified paint loading. Sensitivity measurements following the paint loading shall be within 25 percent of the average of the readings measured prior to the paint loading.

Tests on Thermoplastic Materials Sec. 12-72-304.

(a) ***General.*** *Thermoplastic materials included for the sole support of current carrying parts or as an enclosure of an appliance shall be subjected to the tests included in Sections 12-72-304(b) - (i) inclusive. Where possible, the complete appliance shall be used.*

(b) ***Temperature Test.***

1. There shall be no excessive warping or exposure of high- voltage uninsulated current carrying parts so as to impair operation when representative samples of a plastic material are aged for seven hours in an air circulating oven maintained at 90? C (194? F).

2. At least three representative samples shall be placed in the oven. At the end of the seven hours, the samples shall be removed, permitted to cool and then examined for adverse distortion.

(c) ***Flame Test.*** *A plastic material employed as part of an appliance for the sole support of current carrying parts or as an enclosure shall not continue to burn for more than one minute after the fifth five-second application of a test flame, with an interval of five seconds between applications of the flame. There shall be do dripping of particles, complete consumption of the sample during the test and the material shall not be destroyed in the area of the test flame to such an extent that the integrity of the enclosure is affected. Three samples of the material or three test specimens consisting of a part or section of the polymeric enclosure shall be subjected to this test. Consideration may be given to leaving in place components and other parts which may influence the performance.*

(d) Two of the three test samples shall show acceptable performance. If one sample fails, the test shall be repeated on a new sample with the flame applied under the same conditions as for the failing sample. If the new specimen fails to comply with the requirements, the material is not acceptable. The following test equipment is employed.

1. ***Test chamber.*** *The test chamber consists of a sheet-metal cell 2 feet by 1 foot by 1 foot, open at the top and on one long side. The chamber shall be located so that an ample supply of air is provided, but the sample is not*

subjected to drafts. The chamber may be placed in a hood, provided that the fan is turned off during the test and is allowed to run only between tests to remove fumes.

2. A ring stand with a suitable clamp is used for supporting the specimens.

3. ***Burner and mounting block.*** *The test flame is to be obtained by means of a Tirrill Burner having a nominal bore of 3/8 inch. The tube length above the primary air inlets is to be approximately 4 inches. The burner is to be adjusted so that, while the burner is in a vertical position, the overall height of the flame is 5 inches and the height of the inner blue cone is 11/2 inches. A mounting block is to be provided so that the burner may be positioned at an angle of 20 degrees from the vertical.*

4. A stopwatch or clock.

5. Circulating-air oven.

(e) ***Conditioning and Mounting.*** *The test samples are to be conditioned by placing them in a circulating-air oven maintained at a uniform temperature not less than 10? C higher than the maximum temperature of the material measured under normal operating conditions but not less than 70? C in any case. The samples are to remain in the oven for seven days. Prior to test the samples are to be returned to room temperature. The test sample is to be mounted as intended in service in the test chamber. The test flame is to be applied at an angle of 20 degrees from the vertical to any portion of the interior of the enclosure judged as liable to be ignited by proximity to live or arcing parts, coils, wiring, etc. The test flame shall be applied to a different location on each of the three samples tested. The test flame is to be applied for five seconds and removed for five seconds. The operation is to be repeated until the specimen has been subjected to a total of five applications of the test flame.*

(f) ***Impact Test.*** *An appliance employing a thermoplastic enclosure shall withstand three 5 foot-pound impacts without exposure of live parts, impairment of the operation of the appliance or result in a shock hazard. Each of two units is to be mounted securely in a position of normal use on a surface representative of a typical installation. Three 5 foot-pound impacts are to be applied to each sample, each trial on a different section of the enclosure, by means of a 1.18 pound, 2-inch diameter steel sphere swung through a pendulum arc from a sufficient height to apply 5 foot-pounds of energy. Following the impacts, the unit is to be examined for damage and checked for normal operation by being energized from a source of rated voltage and frequency. Cracking of the enclosure is acceptable if it does not impair normal operation, but is not acceptable if a dust or moisture tight enclosure is required.*

(g) ***Infrared Analysis of Plastics.*** *The basic composition of a plastic material employed for the sole support of current carrying parts or an enclosure is to be by infrared analysis.*

(h) ***Sample Preparation.*** *The general technique for preparing plastics for infrared analysis is to dissolve the sample in a suitable boiling hot solvent. The resulting solution is then to be placed on a sodium chloride plate from which the solvent is evaporated by gentle heating, thereby leaving a reasonably uniform thin film of the plastic on the sodium chloride plate. The salt plate is then mounted in a spectrometer and the infrared spectrum of the plastic is recorded. A suitable solvent is one which will dissolve the plastic without reacting with it and which can be readily evaporated on gentle heating. Examples of solvents suitable for certain polymer types are: acetone-for polymers of high oxygen content, e.g., polyesters and phenolic resins.*
o-dichlorobenzen-for simple vinyl type polymers e.g., polyvinylchlorides. n,n-dimethyl formamide-for polymers of nitrogen content, e.g., polyamides. Some high molecular weight or highly cross-linked polymers which are insoluble in all volatile solvents are to be prepared by the pressed halide-disk technique. A few milligrams of the plastic are to be removed from the surface of a sample by a fine file. These filings are to be ground in a mechanical vibrating ball mill for three to five minutes. Care must be taken to reduce the particle size to a size (approximately 2 micrometers) smaller than that of the shortest wave length to be scanned so as to minimize scattering effects. The appropriately ground sample is to be intimately mixed with spectroscopic grade potassium bromide and a sufficient amount of this mixture to produce a 1 mm thick, 1/2-inch diameter disk is to be placed in an evacuable die. The die is to be placed under vacuum and a pressure of 10,000-15,000 psi is to be applied. The pressed disk is removed from the die and mounted in a spectrometer, and the infrared spectrum of the plastic is recorded.

(i) ***Instrumentation.*** *The infrared spectrum from 2.0-15.0 micrometers (5000-667 cm-1) of a given plastic is to be obtained on an optical double beam recording infrared spectrometer, having either a grating or sodium chloride prism dispersing element.*

TABLE 12-72-3A-CAST METAL ENCLOSURES

USE OR DIMENSIONS OF AEA INVOLVED	MINIMUM THICKNESS IN INCHES	
	Die-cast <Metal	Cast Metal of Other Than the Die-cast Type
Area of 24 square inches or less and having no dimension greater than 6inches	1/16	1/8
Area greater than 24 square inches or having any dimensions greater than 6 inches	3/32	1/8
At a threaded conduit hole	¼	¼
At an unthreaded conduit hole	1/8	1/8

TABLE 12-72-3B-SHEET METAL ENCLOSURES

MAXIMUM ENCLOSURE DIMENSIONS		MINIMUM THICKNESS OF SHEET METAL IN INCHES		
Any Linear Dimension in Inches	Area of any Surface in Square Inches	Steel		COPPER, BRASS OR ALUMINUM
		Coated	Uncoated	
12	90	0.035 (20)	0.031 (20)	0.045 (16)
24	360	0.046 (18)	0.042 (18)	0.058 (14)
48	1,200	0.057 (16)	0.053 (16)	0.075 (12)
60	1,500	0.070 (14)	0.067 (14)	0.095 (10)
Over 60	Over 1,500	0.097 (12)	0.093 (12)	0.122 (8)

TABLE 12-72-3C-THICKNESS OF GLASS COVERS

MAXIMUM SIZE OF OPENING		MINIMUM THICKNESS OF GLASS IN INCHES
Length or Width in inches	Area in Square Inches	
4	16	1/16
12	144	1/8
Over 12	Over 144	1

[1]One-eight inch or more, depending upon the size, shape and mounting of the glass panel

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TABLE 12-72-3D-THICKNESS OF INSULATING MATERIAL

MAXIMUM DIMENSION IN INCHES	MAXIMUM AREA IN SQUARE INCHES	MINIMUM THICKNESS IN INCHES
24	360	3/8[1]
48	1,152	½
48	1,728	5/8
Over 48	Over 1,728	¾

[1]Material less than 3/8 inch but not less than 1/8 inch in thickness may be employed for a panel if the panel is adequately supported or reinforced to provide rigidity not less than that of a 3/8 inch may be employed for subassemblies, such as supports for terminals for internal wiring, resistors and other components

TABLE 12-72-3E-MINIMUM SPACINGS

POINT OF APPLICATION	MINIMUM SPACING-INCHES[1]		
	Voltage Range Volts	Through Air	Over Surface
To walls of enclosure			
Cast mental enclosures	0-300	¼	¼
Sheet metal enclosures	0-300	½	½
Installation wiring terminals	0-30	?	3/16
With barriers-see Section 12-72-302 (t)	31-150	?	¼
		¼	3/8
Item 6	151-300		
Without barriers	0-30	3/16	3/16
	31-150	¼	¼
		¼	3/8
	151-300		
Rigidly clamped assemblies[2]			
100 volt-amperes maximum	0-30	1/32[3]	1/32[3]
Over 100 volt amperes		3/64	3/64
	0-30	1/16	1/16
	31-150	3/32	3/32
	151-300		
Other parts	0-30	1/16	?
		?	¼
	31-150	¼	3/8
	151-300		

[1]Measurements are to be made with solid wire of adequate ampacity for the applied load connected to each terminal. In no case is the wire to be smaller than No.18AWG.
[2]Rigidly clamped assemblies include such parts as contact springs on relays or cam switches, printed wiring boards, etc.
[3]Spacings less than those indicated, but in no case less than 1/64 inch are acceptable for connection of integrated circuits and similar components where the spacing between the adjacent connecting wires on the component is less than 1/32 inch.

TABLE 12-72-3F-MAXIMUM TEMPERATURE RISES

DEVICE OR MATERIAL	DEGREES ° C	DEGREES ° F
1. Any point on rectifiers:		
A. Copper oxide	30	54
B. Germanium	50	90
C. Magnesium	95	171
D. Selenium	50	90
E. Silicon	75	135
2. Rubber or thermoplastic insulation	35[1]	63[1]
3. Vanished cloth insulation	60	108
4. Fuses	65	117
5. Surfaces adjacent to or upon which the unit may be mounted in	65	117

1. Wood or other combustible material	65	117
2. Fiber used as electrical insulation	65	117
3. Class A (Class 105) insulation	65[3]	117[3]
4. Class B (Class 130)insulation	85[3]	153[3]
5. Phenolic composition used as electrical insulation	125	225
6. Capacitors	40	72
7. Solid state devices (transistors, silicon-controlled rectifiers, etc.) integrated circuits	See 4	
8. Wirewound resistor	150[2]	302[2]
9. Carbon resistor	See4	
10. Sealing compound	15	(27) less than the melting point[2]

[1]This limitation does not apply to an insulated conductor or a material which has been investigated and accepted for a higher temperature.
[2]These are limiting temperatures, not temperature rises.
[3]10° C (18° F) higher on coil insulation if measured by the resistance method.
4 The temperature of a solid-state device shall not exceed 50 percent of its rating during the normal standby condition. The temperature of a solid-state device shall not exceed 75 percent of its rated temperature under any other condition of operation of the complete unit which produces the maximum temperature dissipation of its components. For reference purposes 0° C (32° F) shall be considered as 0 percent. For integrated circuits the loading factor shall not exceed 50 percent of its rating under the normal standby condition and 75 percent under any condition of operation. Both solid-state components and integrated circuits may be operated up to the maximum ratings, under any one of the following conditions:
4 ? [1] All components comply with the requirements Mil-Std. 883C.
4 ? [2]A quality control program is established by the manufacturer consisting of inspection and test of 100 percent of all components, either on an individual basis, as part of a subassembly, or equivalent.
4 ? [3]Each assembled production unit is subjected to a burn in test while in an alarm condition for 24 hours while connected to a source of rated nameplate voltage and frequency in an ambient of at least 49° C (120° F) followed by an operational test the maximum temperature on a carbon resistor shall be not greater than 50° C during normal standby condition and not greater than 75° C during the alarm condition.

TABLE 12-72-3G-OBSCURATION-OPTICAL DENSITY CHART (Based on a 5-foot light beam)

METER READING (Microamperes)	PERCENT PER FOOT OBSCURATION ° u	TOTAL OBSCURATION ° ?	TOTAL OPTICAL DENSITY ° D t	OPTIC DENSITY PER FOOT ° Dt
100.0	0,0000	0.0000	0.0000	0.0000
99.5	0.1002	0.5001	0.0022	0.0004
99.0	0.2008	1.0001	0.0044	0.0009
98.5	0.3019	1.5001	0.0066	0.0013
98.0	0.4033	2.0001	0.0088	0.0018
97.5	0.5051	2.5002	0.0110	0.0022
97.0	0.6074	3.0002	0.0132	0.0027
96.5	0.7101	3.5002	0.0155	0.0031
96.0	0.8132	4.0003	0.0177	0.0036
95.5	0.9167	4.5003	0.0200	0.0040
95.0	1.0227	5.0003	0.0223	0.0045
94.5	1.1251	5.5004	0.0246	0.0049
94.0	1.2300	6.0004	0.0296	0.0054
93.5	1.3353	6.5004	0.0292	0.0058
93.0	1.4410	7.0005	0.0315	0.0063
92.5	1.5473	7.5005	0.0339	0.0068
92.0	1.6539	8.0005	0.0362	0.0072
91.5	1.7611	8.5005	0.0386	0.0077
91.0	1.8687	9.0006	0.0410	0.0082
90.5	1.9768	9.5006	0.0434	0.0087
90.0	2.0853	10.0006	0.0458	0.0092
89.5	2.1944	10.5007	0.0482	0.0096
89.0	2.3039	11.0007	0.0506	0.0101
88.5	2.4139	11.5007	0.0531	0.0106
88.0	2.5244	12.0008	0.0555	0.0111

87.5	*2.6355*	*12.5008*	*0.0580*	*0.0116*
87.0	*2.7470*	*13.0008*	*0.0605*	*0.0121*
86.5	*2.8590*	*13.5008*	*0.0630*	*0.0126*
86.0	*2.9716*	*14.0009*	*0.0655*	*0.0131*
85.5	*3.0847*	*14.5009*	*0.0680*	*0.0136*
85.0	*3.1984*	*15.0009*	*0.0706*	*0.0141*
84.5	*3.3125*	*15.5010*	*0.0732*	*0.0146*
84.0	*3.4272*	*16.0010*	*0.0757*	*0.0152*
83.5	*3.5425*	*16.5010*	*0.0783*	*0.0157*
83.0	*3.6583*	*17.0011*	*0.0809*	*0.0162*
82.5	*3.7746*	*17.5011*	*0.0836*	*0.0167*
82.0	*3.8916*	*180011*	*0.0862*	*0.0172*
81.5	*4.0091*	*18.5011*	*0.0889*	*0.0178*
81.0	*4.1271*	*19.0012*	*0.0915*	*0.0183*
80.5	*4.2458*	*19.5012*	*0.0942*	*0.0188*
80.0	*4.3651*	*20.0012*	*0.0969*	*0.0194*

FIGURE 12-72-3-1-SMOKE DETECTOR TEST CHAMBER

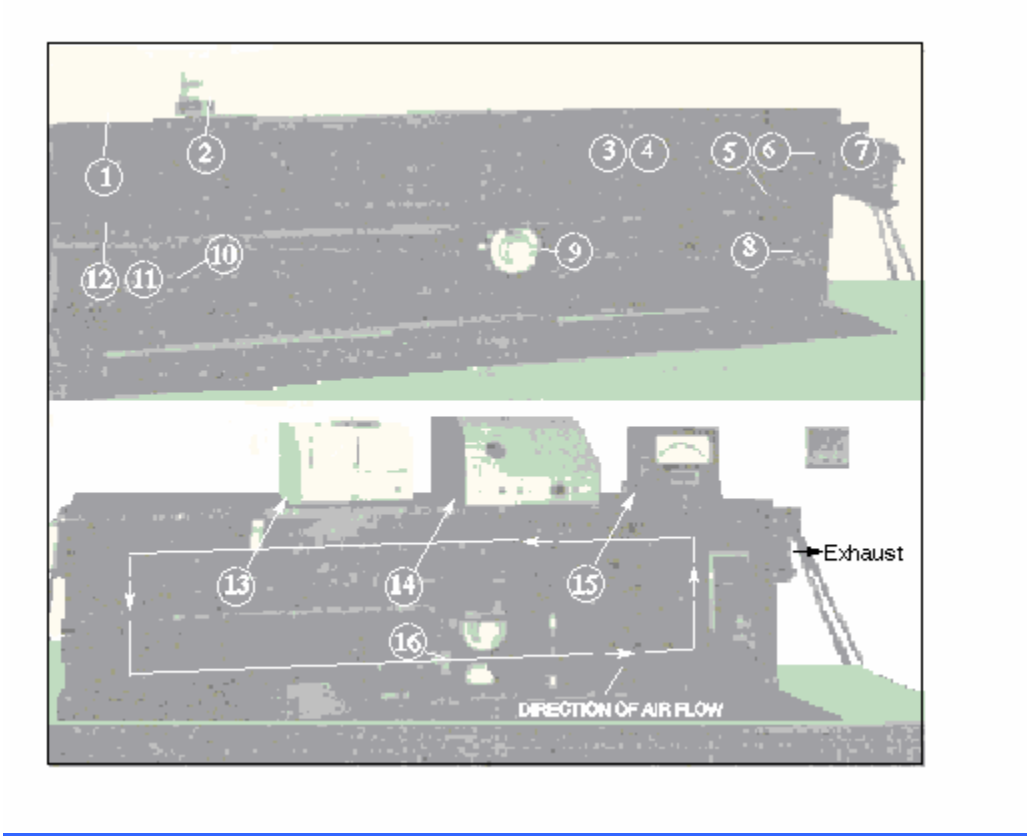


FIGURE 12-72-3-2-FIRE TEST DETECTOR INSTALLATION

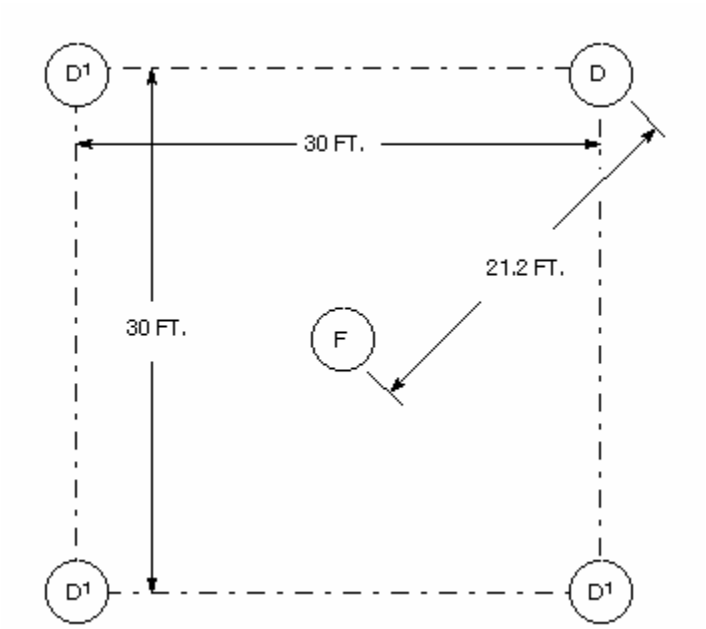
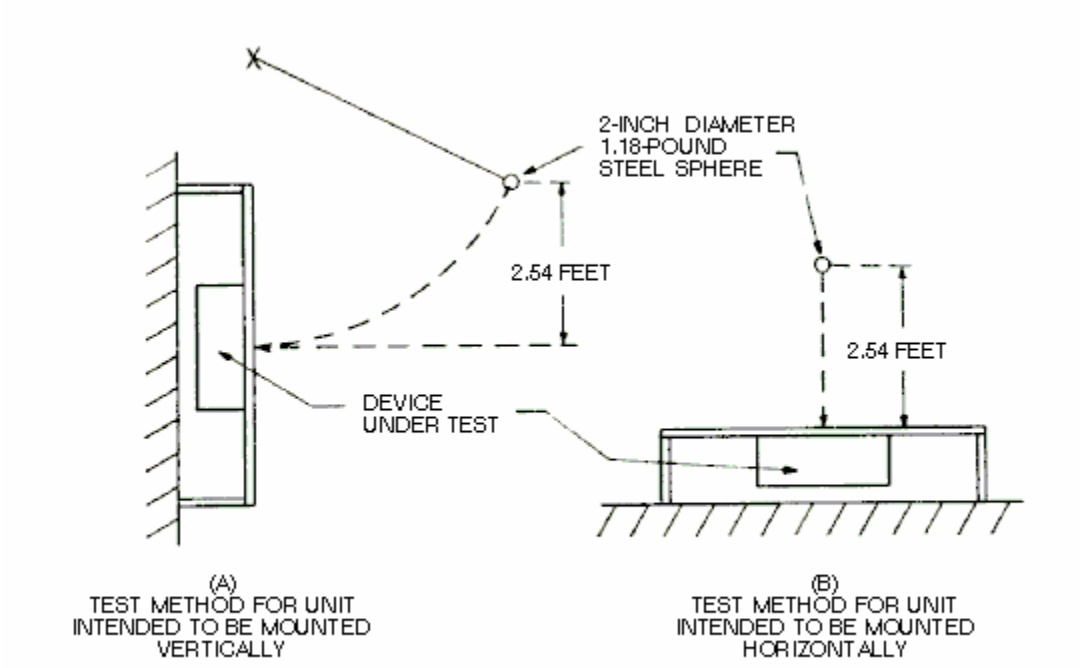


FIGURE 12-72-3-3-JARRING TEST



Notation for all of the above express terms
Authority: Health & Safety Code §13143
Reference: Health & Safety Code §13143, 18949.2(B)(C)

ITEM 24-2 – Committee Recommendations

A AA D FS

*** * ***
(END OF ITEM)

INITIAL STATEMENT OF REASONS

STATEMENT OF SPECIFIC PURPOSE AND RATIONALE
FOR THE PROPOSED AMENDMENT TO THE CBC, PART 12:
The proposed action will codify in the current edition of the CCR, Title 24, Part 12, the following chapters of the 1998 edition of the CCR Title 24, Part 12:

Part 12-1 This section provides the administrative information for Part 12.

Part 12-4-1 This section provides standards for Smoke or Heat Ventilators

Part 12-7-1 This section provides fire resistive standards for fire tests of building construction and materials.

Part 12-7-2 This section provides fire resistive standards for fire dampers.

Part 12-7-3 This section provides fire resistive standards for furnaces

Part 12-7-4 This section provides fire resistive standards for fire door assemblies.

Part 12-8-1 This section provides fire resistive standards for wall and ceiling materials.

Part 12-8-1A This section provides calculations for the total rate of heat and carbon monoxide or carbon dioxide production.

Part 12-8-1B These sections provide information on mounting techniques for wall and ceiling interior finish materials.

Part 12-10-1 This section provides standards for power-operated exit doors.

Part 12-10-2 This section provides standards for single point latching or locking devices.

Part 12-10-3 This section provides standards for emergency exit and panic hardware.

Part 12-71 This section provides standards for air filters.

Part 12-72-1 This section provides standards for protective signaling systems.

Part 12-72-2 This section provides standards for single and multiple station fire alarm devices mechanically operated.

Part 12-72-3 This section provides standards for combustion products under protective signaling systems smoke detectors.

The specific purpose of the rulemaking effort as a whole is as follows:

The "Special Test Standards and Methods" (Title-19 CCR) provides the foundation for many of the State Fire Marshal's adoption of building regulations. The "Special Test Standards and Methods" contains the scientific background for testing materials and assemblies while at the same time delineating specific design criteria.

The "Special Test Standards and Methods," like the rest of the SFM building regulations, existed in Title 19 of the California Code of Regulations. The establishment of the Building Standards Commission and the Office of Administrative Law enabled the SFM to separate building standards from non-building standards. Building standards were established in Title-24 of the California Building Code while non-building standards remained in Title-19 California Code of Regulations.

Generally, "Special Test Standards" noted above were transferred, according to Part 12, History Note in the 1998 CBC, on January 1, 1989. Once in place, the State Fire Marshal repealed the test standards in Title 19, according to the history note for Article 80, effective August 9, 1989 as a change without regulatory effect pursuant to Section 100. This time frame allowed for overlap in the standards from one code to another.

The California Building Standards Commission could not locate the section 100 document that administratively placed these standards in the California Building Code. During the 2001 code adoption the CBSC decided not to adopt or publish these important standards. This rulemaking proposal is necessary to correct the poor record keeping of the SFM and CBSC, by reestablishing the test standards in Part 12 of the California Building Code.

The actions described above are reasonably necessary to carry out the purpose for which it is proposed. The rationale for these actions is to establish minimum requirements for the prevention of fire and for the protection of life and against fire and panic in any building or structure used or intended for use as a state regulated occupancy.

TECHNICAL, THEORETICAL, AND EMPIRICAL STUDY, REPORT, OR SIMILAR DOCUMENTS:

The SFM used historical information relating to the move of these standards from Title 19, 1988 to 1990. This historical data indicates that these standards were editorially transferred from the Title 19, CCR to Part 12, Title 24, CCR. These changes were without regulatory effect pursuant to Section 100 of the Administrative Procedures Act.

CONSIDERATION OF REASONABLE ALTERNATIVES:
Alternatives Considered:

1. Abandon test standards by not readopting them in the building code.

   Rejected: This is not an attractive alternative for the State Fire Marshal. The "Special Test Standards" continue to validate specific provisions of the building code.

2. Adopt similar standards from another source.

   Rejected: Variations of the specific standards under consideration have coexisted in Title 19 and the Uniform Building Code since 1976. The SFM is intends to continue with the standards which formed the original foundation of SFM code adoption.

REASONABLE ALTERNATIVES THE AGENCY HAS IDENTIFIED THAT WOULD LESSEN ANY ADVERSE IMPACT ON SMALL BUSINESS:
The SFM has determined that this proposed amendment will not have an adverse impact on small business. Therefore, no alternatives have been identified or that have otherwise been identified and brought to the attention of the SFM that would lessen any adverse impact on small business.

FACTS, EVIDENSE, DOCUMENTS, TESTIMONY, OR OTHER EVIDENSE OF NO SIGNIFICANT ADVERSE IMPACT ON BUSINESS:
The SFM has made an initial determination that the proposed action will not have a significant adverse impact on business.

DUPLICATION OR CONFLICT WITH FEDERAL REGULATIONS:
The SFM has determined that this proposed rulemaking does not unnecessary duplicate or conflict with federal regulations contained in the Code of Federal Regulations that address the same issues as this proposed rulemaking.